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How Humans Develop Trust in Communication Robots: A Phased Model Based on Interpersonal Trust

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***Abstract*—The purpose of this study was to propose a model of development of trust in social robots. Insights in interpersonal trust were adopted from social psychology and a novel model was proposed. In addition, this study aimed to investigate the relationship among trust development and self-esteem. To validate the proposed model, an experiment using a communication robot NAO was conducted and changes in categories of trust as well as self-esteem were measured. Results showed that general and category trust have been developed in the early phase. Self-esteem is also increased along the interactions with the robot.**

***Index Terms*—trust; social robot; communication robot; self-esteem**

I. Introduction

Trust is essential for acceptance and continuous use of technology. The conventional theories of human trust in technology have two common assumptions. Firstly, the technology does not change over time. Users expect the technology always functions in the same way. Secondly, the technology does not have intentions and only reacts passively to the user's actions.

However, recent development in AI and communication robots suggests that the assumptions are not always valid because such technology evolves and conveys its own intentions. Thus it is possible that human users may develop trust in such technologies in a different way.

As human users may recognize some kinds of personality among technologies such as humanoids or software agents, it might be beneficial to adopt insights from interpersonal trust that has been studied in social psychology.

Self-esteem, a heavily studied construct in psychology, contributes to the development of trust in others. That is, people with high self-esteem are more willing to trust others [1]. If self-esteem is also related to trust on such information technologies, it might suggest possible interventions to promote user's trust on such technologies.

The purpose of this study was to propose a model of development of trust in communication robots, based on insights driven from social psychology. In addition, this study aimed to investigate the relationship among trust development and self-esteem. An experiment was conducted with a communication robot NAO [2]. Changes in several categories of trust as well as self-esteem were measured.

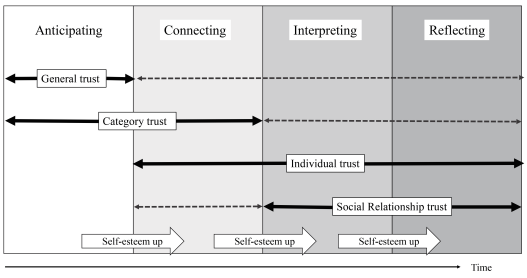

Fig. 1. Proposed model of trust development process.

II. Model of Trust Development Process

Yamagishi argued categories of interpersonal trust [3]. Specifically, *general trust* involves trust on humans in general, while category trust refers to trust on a specific category of people (i.e. professors). Individual trust denotes trust on a specific individual. As people interact along time, they may also develop trust based on relationship. This trust was referred to as social relation trust. Yamagishi's categories fit with the concept of trust development along time phases.

McCarthey and Wright [4] have proposed a framework to capture people's experiences with technology. To better understand change in technology experience, the framework introduced six phases of time: anticipating, connecting, interpreting, reflecting, appropriating, and recounting.

This study proposed a model of development process of human trust in social robots, adopting the categories of interpersonal trust by Yamagishi [3], and the first four phases of technology experiences by McCarthey and Wright [4]. Fig.1 illustrates the proposed model.

General and category trust would be developed in early phase of anticipating, while individual trust would start its development in connecting phase. Social relationship trust would be developed in interpreting and reflecting phase.

III. Methods

An experiment was conducted to illustrate how categories of trust develop over phases of human-robot interaction.

Subjects were 16 graduate and undergraduate students aged between 18 and 24 ($M = 22.1$, $SD = 2.0$). Of those, 10 were males and six were females.

After subjects were given general explanation of experiment and signed on a consent form, they were asked to fulfill the first questionnaire that assessed attitude towards robots, general trust in robots, and category trust in social robots, self-esteem and demographic information.

Attitudes towards robot was measured by the Multi-dimensional Robot Attitude Scale [5]. Question items corresponding to three sub-dimensions were adopted: familiarity, interest, and negative attitude. Self-esteem was measured using Rosenberg Self-Esteem Scale translated in Japanese [6]. General, category, and individual trust were assessed using the 14 question items proposed by Schaefer [7]. The description referring to robot in the original items were modified to refer to robots in general (general trust), social robots (category trust), NAO (individual trust), respectively.

Afterwards, the subjects watched a short video introducing NAO (*anticipation* phase). Subjects were then asked to fulfill the second questionnaire assessing general trust in robots, category trust in communication robots, and individual trust in NAO as well as self-esteem.

The experimenter showed NAO to the subject for the first time (*connecting* phase). After watching the robot and listening short greetings by the robot, subjects fulfilled the third questionnaire assessing general, category, and individual trust, as well as social relationship trust and self-esteem. Social relationship trust was measured using ten question items representing trust based on social relations adopted from the questionnaire developed to assess peer relationship [8].

Finally, subjects were instructed to have a conversation with the robot (*interpreting phase*). NAO initiated conversations with some questions about the subject and continued dialogs by means of Wizard of Oz method.

Subjects were then asked to fulfill the last questionnaire to assess general, category, individual, and social relationship trust as well as self-esteem.

IV. Results

Fig. 2 shows changes in general, category, and individual trust of subjects. General and category trust have been developed in the early anticipation phase. on the other hand, individual trust did not change much through the connecting and interpreting phases.

Social relationship trust increased through interpreting phase ($M_{before} = 38.6$, $SD = 4.4$, $M_{after} = 41.8$, $SD = 9.2$). However, the t-test revealed that the change was not significant.

Fig. 3. shows the changes in self-esteem measure. The score increased moderately over the period of interaction.

There was a significant correlation between self-esteem and general trust ($p < .05$).

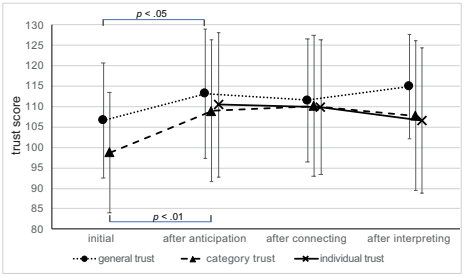

Fig. 2. Means and standard deviations of general-, category-, and individual-trust scores by interaction phases.

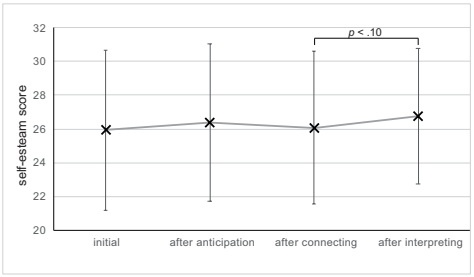

Fig. 3. Means and standard deviations of self-esteem score by interaction phases.

V. Discussion

This study proposed a model of development process of human trust in social robots. An experiment showed early evidences to suggest the validity of the proposed model.

The experiment reported in this paper did not have sessions corresponding to the reflections phase of the model. As social relationship trust is considered to be developed over a long time, observations for longer period is needed to further understand social relationship trust. A more diverse sample of participants should also be included in future research.

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