Validation of the Robot Social Attributes Scale (RoSAS) for Human-Robot Interaction through a Human-to-Robot Handover Use Case

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Abstract— **This work aims to validate the Robotic Social Attributes Scale (RoSAS) for human-robot interaction. The RoSAS evaluates the social perception of robots. It measures an inventory of 18 items that are collected into three robot attributes: competence, warmth, and discomfort. We apply RoSAS to a human-to-robot handover and confirm the internal consistency and unidimensionality of each attribute. This validates the scale in this use case and suggests a more general applicability to other physical human-robot interactions including collaborative manipulation or turn-taking tasks.**

I. INTRODUCTION

Understanding the social perception of robots is becoming increasingly important as human-robot interactions occur more frequently in factory, home, workplace, or medical environments. Indeed we instinctively judge robots based on our social norms, observing how they look, collaborate, and behave themselves. Tailoring robots accordingly should lead to higher quality interactions. To assist in this effort, Carpinella et al. have developed a Robotic Social Attributes Scale (RoSAS) designed to measure user judgments of robots based on prior work in psychology and human-robot interaction (HRI) [1].

Given its recent development, however, the RoSAS has not yet been applied to, or validated for HRI. As such, we examine whether the RoSAS attributes remain internally consistent given an HRI context, in particular human-to-robot handovers. Once validated, this will also allow us to study how varied robot behaviors affect user perception.

II. BACKGROUND

The RoSAS is a psychometric instrument aimed towards measuring social perception and judgments of robots across multiple contexts and robotic platforms [1]. The development of the RoSAS is based upon the Godspeed scale developed by Bartneck et al. [2], and claims to improve cohesiveness, eliminate unnecessary dimensions through factor analysis, and not be tethered to specific types or models of robots. The scale defines three underlying robotic attributes: competence, warmth, and discomfort. It measures these using an inventory of 18 items shown in Table I. The scale was validated by Carpinella et al. on a visual task in which users compared images of human, robot, and blended human-robot faces. In contrast to their work, we are proposing to use RoSAS to evaluate a physical human-robot interaction.

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TABLE I

INVENTORY OF 18 ROSAS ITEMS ASSIGNED TO THREE ROBOT ATTRIBUTES.

Competence	Warmth	Discomfort
Reliable	Organic	Awkward
Competent	Sociable	Scary
Knowledgeable	Emotional	Strange
Interactive	Compassionate	Awful
Responsive	Happy	Dangerous
Capable	Feeling	Aggressive

III. HANDOVER EXPERIMENT

A. Experimental Design

We validate the RoSAS on a study of human-to-robot handovers depicted in Fig. 1. More generally, the study aims to clarify how varied robot behaviors affect both the user's perception of the robot as well as the proxemics and kinodynamics of the handover interaction. As such, we systematically tested three variations: the initial position of the arm prior to handover (up and down as shown in Fig. 1), the grasp method (quick - where the robot magnetically draws the baton into its grasp, and mating - where the robot carefully moves into flush contact with the baton before grasping), and the retraction speed (slow and fast) following the grasp. The initial arm position was chosen as a factor to determine how people approach and direct handover gestures to a disembodied robot arm and how these gestures compare to human receivers studied in prior work [3], [4]. The retraction speed and grasp type factors were selected to examine the force/torque interaction between the giver and receiver and to establish what dynamic negotiations occur during human-to-robot handovers.

B. Experimental Setup

A KUKA LBR iiwa 7 R800 robot was used to receive objects from participants. The robot was mounted as shown in Fig. 1 and fitted with a simple electromagnetic gripper. When activated, the gripper allows the robot to securely grasp the end of a magnetic handover baton.

In the study, participants initiate the handover by holding out the baton towards the robot, similar to how handovers have been initiated in previous studies [4]. If the baton is in the robot's reachable workspace, it proceeds to move to

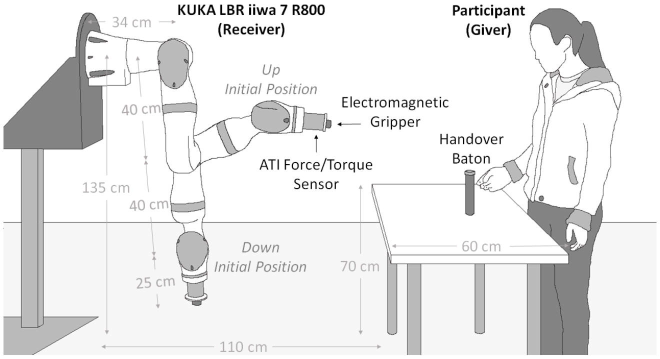

Fig. 1. Experimental setup for the handover experiment. Both the *up* and *down* initial arm positions were used in the experiment.

grasp the object. Once certain grasp conditions are met, the robot will activate the electromagnet and begin retracting the arm and baton by 10cm, before moving into the arm down position (see Fig. 1).

C. Participant Task

Twenty-two participants (11 females, 11 males), aged 22-52 years [M = 30.32, SD = 8.12] completed the study. For each trial, participants picked up the baton off the table and initiated a handover to the robot after hearing the experimenter say 'go'. Upon detecting the baton in its workspace, the robot would move to retrieve the baton in a way that was consistent with the condition being tested. Three trials were performed for each condition. Following each set of three handover trials for a condition, participants were asked to complete the full RoSAS inventory which asked them to rate how closely each of the 18 items associated with the robotic handovers they just performed. Ratings were on a scale from 1 to 7 where 1 was 'not at all', 4 was 'a moderate amount', and 7 was 'very much so'. Each experiment session lasted approximately 30 minutes.

IV. RESULTS

To validate RoSAS, we conducted an internal consistency test to measure how closely the RoSAS inventory items fit within the three attributes (competence, warmth and discomfort). For testing, we use Cronbach's alpha and consider $\alpha \geq .80$ to represent high scale reliability. Items for competence (α = .90), warmth (α = .94) and discomfort (α = .81), all scored above this threshold suggesting that the items have relatively high internal consistency within their respective attributes.

In addition to investigating consistency, we performed a factor analysis to ensure that the items for each attribute are unidimensional. Here, we examined eigenvalues which represent how much variation in each attribute is explained by each item; the larger the eigenvalue, the more variation the item explain. For an attribute to be unidimensional, we would expect to see one item account for a large portion of the variance within the attribute, and other items account for much less variation. Results show that the first items in the competence, warmth and discomfort attributes explains 67.7%, 76.9%, and 53.5% of the variance respectively. This suggests that the items for each attribute are unidimensional.

V. DISCUSSION

Carpinella et al. claim that "RoSAS provides a psychometrically validated, standardized measure that can be used to measure robots developed by different people in different places for differing purposes and over time" [1]. As this is the first known usage of the RoSAS for human-robot interaction, we felt it important to re-validate the scale using the data collected in our study. Examination of the results show that the 18 items of the scale conform to the three attributes of the scale - competence, warmth and discomfort - with a high degree of consistency. Additional testing showed that the items of each attribute were highly unidimensional. Thus, the results suggest that the application of RoSAS for this work is validated.

The results of the study presented here offers a glimpse into how users can accurately and consistently ascribe social attributes to robots during collaborative tasks and how the RoSAS can be used to evaluate these perceptions. In particular, we have shown that users can consistently assign social attributes to robot behaviors using the RoSAS. As such, we have no reason to believe that RoSAS could not also be justifiably applied to other HRI tasks, particularly ones involving physical interactions where users also experience robot behaviors (movement speed, proximity, forces and torques). In future work, however, we will continue to also validate RoSAS with other physical HRIs such as collaborative lifting of objects, turn-taking tasks, and navigation within crowds.

For the handover study, the next steps will be to analyze the RoSAS data to determine if there are any main or interaction effects when varying the initial position, grasp type, and retraction speed of the robot during the handover. Additionally, we wish to determine if there are any effects relating to repeated interactions with the robot. For example, do users become more socially accepting or comfortable with the robot over time.

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