# Robot Social Skills for Enhancing Social Interaction in Physical Training

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***Abstract*—In this paper, we identify the effects of robot social skills for enhancing social interaction in a physical training. To that end, we designed a physical training scenario and conducted an experiment with 28 participants using the humanoid robot NAO. As a result, there were significant differences between the control group where social skills were not used, and the experimental group where social skills were used by the robot.**

***Keywords—Soically Assitive Robot, Robot Social Skills, Physical Training, Human-Robot Interaction (HRI)***

## I. INTRODUCTION

Robot social and interactive skills are necessary to maintain social interaction and collaborate with other robots or humans. In this contexts, the socially interactive robot plays a key role to interact and collaborate with humans [1-2]. Some work has been done to provide assistance to human users through robot social interaction. For example, the socially assistive robot exercise coach system designed to engage elderly people in physical exercise [3-4]. A study on the adaptive interactions between robots and children is introduced by Ros et al. [5]. In their work they propose a robot dance tutor that provide social interaction to interact with children in a dance activity.

The purpose of our work was to find effective social cues, and identify the effectiveness of robot social skills including mutual gaze, feedback and social distance in a physical training.

## II. ROBOT SOCIAL SKILLS AND HYPOTHESES

### A. Mutual Gaze

Mutual gaze occurs when two people make eye contact or look into each other's eyes. Mutual gaze is an important part of social communication and perception of others' emotion states and is the one of the foundational skills necessary in the development of joint attention [6]. In this study, mutual gaze is a social skill that can allow the user to concentrate on correctly learning yoga or physical exercise by controlling the robot's gaze using face detection.

### B. Feedback

Motivational feedback is constant approval of how well user are doing the task encourages them to continue [5]. In this work, the robot provide verbal and motivational feedback to the user autonomously according to the result of motion recognition. To permit the robot to recognize a motion, we developed a motion recognizer based on an RGB-D stream of a Kinect sensor.

### C. Social Distance

Social distance has been used as a way to estimate the social relationship between two persons [7]. Social distance is a social skill that maintains a comfortable social space between the robot and the user. If a user got too close to the robot, the robot requested the user to move back in order to maintain social distance.

### D. Hypotheses

Hypothesis 1. Naturalness of the robot by participants will vary with whether the robot use social skills or not.

Hypothesis 2. Perceived intelligent of the robot by participants will vary with whether the robot use social skills or not.

Hypothesis 3. Appropriate gaze of the robot by participants will vary with whether the robot use social skills or not.

Hypothesis 4. Sustainability of the robot by participants will vary with whether the robot use social skill or not.

## III. EXPERIMENTAL

### A. Experimental Design

A total of 28 participants (25 males and 3 females) were recruited for this study. Most of the subjects was a participant who is familiar with the computer and robot. Their ages ranged from 20 - 60 years old.

We used the humanoid robot, NAO that is an autonomous, programmable humanoid robot developed by Aldebaran Robotics. NAO provides face and object recognition, automatic speech recognition, text-to-speech, and whole body motion. We conducted the same experiment with two groups: a control group in which the robot did not use social skills, and an experimental group where the robot employed the social skills including mutual gaze, feedback, and social distance. The study was conducted for about 10 minutes per session, for a

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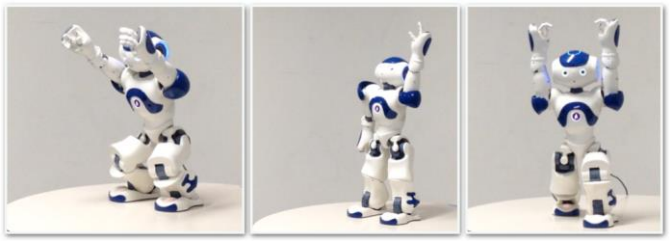
total of 7 sessions. Half of the participants engaged in the control condition, whereas the other half engaged first in experimental condition.

To measure the user's perception of robots for this study we used the modified Godspeed concept, a series of questionnaires [8] which consisted of survey questions on a 7-point Likert scale ranging from 'strongly disagree'(1) to 'strongly agree'(7). Participants answered a questionnaire after each interaction. The questionnaire included questions about the naturalness, perceived intelligence, appropriate gaze, and sustainability of the physical training robot. Data were analyzed by independent t-test using the SPSSWIN21, which is a software package used for statistical analysis.

### B. *Experimental Senario*

We designed a physical training scenario to test the effect of a robot using social skills when interacting with humans. In the physical training scenario, the humanoid robot Nao demonstrated seven yoga and physical exercise poses with different levels of difficulty to human participants (see Figure 1). The scenario began with basic poses and proceeded to applied poses based on the performance of the participant. Before beginning the physical training, an experimenter introduced the robot and yoga or physical exercise poses.



(a) (b) (c)

Fig. 1. NAO robot's pose in physical training. (a) chair pose; (b) raised hand pose (c) warrior pose.

## IV. RESULTS

Figure 2 shows the results of the independent t-test for the two groups and four measurements. Hypothesis 1 was supported. There was significant difference in naturalness reported by the participants, $t = 2.434$, $p < 0.05$, which means the robot interaction including the social skills was more natural. As predicted by Hypothesis 2, there was a significant difference in perceived intelligent, $t = 4.205$, $p < 0.001$, which means that the robot interaction including the social skills were considered more intelligent. Consistent with Hypothesis 3, participants felt that social interaction with mutual gaze was more effective, $t = 2.550$, $p < 0.05$. As predicted by Hypothesis 4, there was a significant difference in sustainability between the two groups after the interaction, $t = 3.019$, $p < 0.01$. Especially, concerning the dominance socially interactive factors that would maintain a natural and sustained interaction, a significant difference is highlighted between the experimental group and control group (see Figure 2). According to the experimental results, it's clear that the interactions with the robot that was using social skills were more effective.

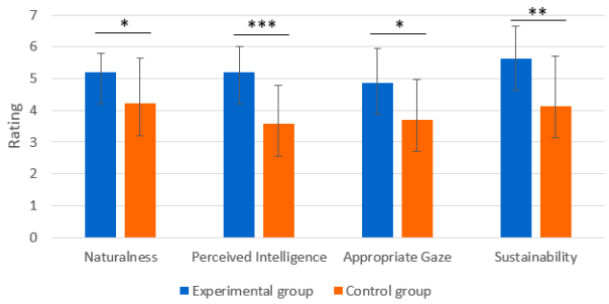



Fig. 2. Result of the independent t-test between experimental and control group: the participants' ratings in response to survey questions on their perception of the robot's natualness, perceived intelligence, appropriate gaze and sustainablity. Note: *: $p < 0.05$, **: $p < 0.01$, ***: $p < 0.001$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## V. CONCLUSION

We presented the effectiveness of robot social skills for enhancing the social interaction in physical training. Also, we conducted a controlled experiment with 28 participants using the humanoid robot NAO. Consequently, there were statistically significant differences in naturalness, perceived intelligence, appropriate gaze and sustainability between the two groups after interaction. Therefore, robot social skills including mutual gaze, feedback, and social distance should be considered as effective social cues in physical training.

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