How Expressiveness of a Robotic Tutor is Perceived by Children in a Learning Environment

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***Abstract*—We present a study investigating the expressiveness of two different types of robots in a tutoring task. The robots used were i) the EMYS robot, with facial expression capabilities, and ii) the NAO robot, without facial expressions but able to perform expressive gestures. Preliminary results show that the NAO robot was perceived to be more friendly, pleasant and empathic than the EMYS robot as a tutor in a learning environment.**

I. Introduction

Social robots are being widely used in a variety of application areas such as entertainment, therapy, assistance and education. Previous studies in HRI have indicated that the physical appearance of the robots [1] as well as their expressiveness can affect the interaction experience, especially with children. Tielman et al. [2] and Leite at al. [3] indicated that children react more expressively and more positively to a robot showing emotion through movement than to a robot that does not.

For tutoring systems, empathy and engagement are key to influencing students' learning experience. Empathy is the psychological process that makes a person feel more congruent with another's circumstances than with their own [4]. In order to embed empathy in learning environments, the tutor needs to be able to perceive, model and reason about the affective states experienced by learners as well as respond emotionally to the situation. Although much work has been done on expressive behaviour, few studies have investigated degrees of expressiveness and the effects on child-robot interaction. Here we describe initial results from a study on the impact of expressiveness on the perceived character of two different types of robots in a tutoring task.

II. Methodology

As part of a collaborative project EMOTE (www.emote-project.eu), we aim to build a socially intelligent, empathic robotic tutor that could play a long-term role in an educational environment. Two different types of robot were used in this study: (i) the EMYS robot, able to display facial expressions [5] using movable eyes with eyelids, and a head in three segments mounted on a movable neck, and ii) the NAO torso robot, able to display expressions using upper body gestures with hands and head (see Figure 1). The EMYS has a female Scottish voice and the NAO robot has a male child voice. The hypothesis for the study is as follows. *H1: There will be differences in user perceptions of the two robots due to the expressiveness of the robot in a learning environment with the robot playing a tutoring role.*

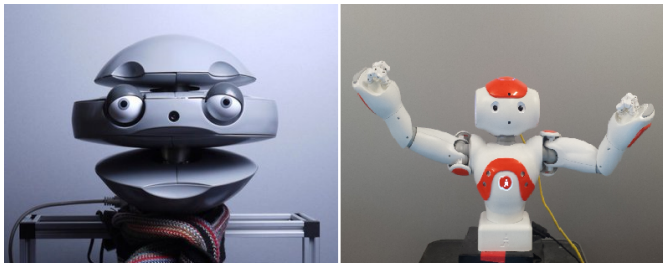

Fig. 1: Happy Expression: EMYS (Left), NAO (right)

A. Experimental Set-up

Participants were assigned randomly to one of two groups (NAO or EMYS). Interaction was limited to 10 minutes and involved the participant using a map-based treasure-hunt application running on a large touch table. In this learning environment, the robot presented them with a series of tasks involving basic skills relating to the use of compass directions, finding distances, and recognising and using map symbols. An example of one step in the map reading task would be to *"find a museum 500 metres north of the railway station"*. The robot presented this task using text-to-speech synthesis (TTS) and gestures.

Fig. 2: EMYS (Left), NAO (right) interacting with students

Figure 2 shows participants interacting with NAO/EMYS and the touch table application. At each step, the robot provides feedback to the pupil using TTS and gestural/facial expressions. For example, a correct answer invokes a happy expression and positive verbal feedback from the robot, such as *"Ok, good"*. There were a total of 31 pupils, aged between 11-14 years old (mean age = 12.40), Females: 16, Males: 15. This was a between subjects study: 16 pupils interacted with the NAO and 15 with the EMYS robot.

B. Questionnaires

Participants took a questionnaire after the interaction. All questions were presented using a five-point Smileyometer (see Figure 3), shown to be an effective instrument for evaluating child-computer interactions [6]. The *friendly* and *pleasant* questions were taken and modified for children from the Godspeed questionnaire series [7], designed as a standard user measurement tool for human-robot interaction. An additonal question was targeted at determining whether the robot was deemed empathic (*"Sometimes the robot did not feel sorry for me when I was having problems"*). This question was adapted from the empathy questionnaire devised and reported in [8].

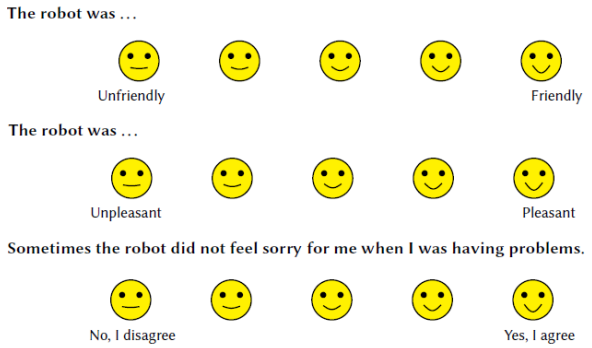

Fig. 3: The smileyometer format of the questionnaire

III. Results

Using a Mann-Whitney unpaired U test, the NAO robot was rated significantly higher than the EMYS robot for the following questions: friendly (p = .010), pleasant (p = .015) and empathic (p = .031). Figure 4 shows the graph of the results and Table I summarises the results.

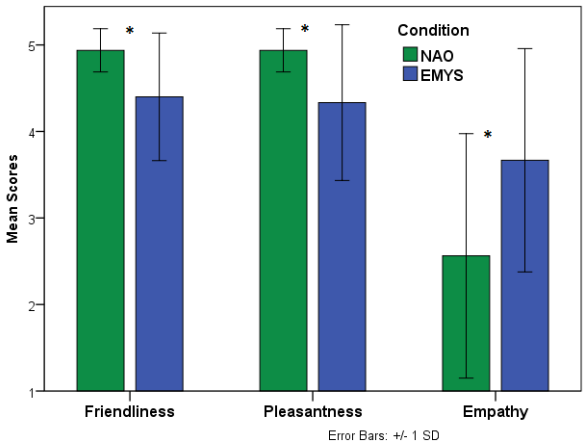

Fig. 4: Questionnaire Results, N=31

IV. Conclusion and Future Work

The initial results indicate that the NAO robot, able to produce expressive behaviours with its hands, was rated higher in terms of friendliness, pleasantness and empathy than the EMYS robot, able to produce facial expressions. We therefore accept the hypothesis H1, having observed a significant difference between the two robots for 3 subjective questions.

Question	NAO		EMYS		Mann-Whitney U		
	M	SD	M	SD	U	Z	p
Friendly	4.94	0.25	4.40	0.73	70.500	-2.559	.010
Pleasant	4.94	0.25	4.33	0.90	70.500	-2.358	.011
Empathy	2.56	1.41	3.67	1.29	67.500	-2.126	.033

TABLE I: Results Summary: M = Mean, SD = Std. dev.

Further subjective analysis and also objective analysis such as task success, time on task, gazing frequency and duration between the two robots will be carried out. This analysis may give further insight into what specific aspect of the embodiment, whether voice, gesture, or physical appearance, contributes most to the effectiveness of the robot in a tutoring role.

In previous studies, a positive effect has been observed with the NAO robot showing emotion on robot-child interaction [2]. Other child-robot interaction studies have indicated that empathy facilitates interaction and that human-based expressions can be successfully implemented by robots [3]. It is clear from the initial study presented here that the physical aspect and expressiveness of the robot must also to be taken into account when designing robots to act as tutors for children in learning environments.

V. Acknowledgments

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