Affect of Robot's Competencies on Children's Perception (Extended Abstract)

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ABSTRACT

The focus of the research described in this paper is to explore children's perception of a social robot's learning abilities and behavior in an educational context. With this purpose, we conducted a long-term study with children in a school by adopting the *learning-by-teaching* learning method. The scenario involves a "learner-agent" (a robot) which seeks help from a child (a teacher) in correcting the shapes of a few letters it writes. Two versions of the robot were built: one where it learns and another where it does not improve over time. The results of the study suggest that children's social relationship with the robot was not affected by the learning abilities of the agent.

Keywords

Social Robotics; Autonomous Robot; Learning Environment; Learning-by-teaching; Long-term Study; Human Robotic Interaction

1. INTRODUCTION

Social robotic agents have been introduced into educational contexts to support new ways of learning. Researchers have explored peer assisted learning approaches such as the *learning-by-teaching* method as a mode of interaction between children and robots. For example, Shizuko et al. [5] conducted a study using the learning method to improve children's knowledge of English words and found that a robot helped children to learn even unknown words. Similarly, a study by Kanda et al. [3] revealed that a robot encouraged children to improve their English and form relationships with them. However, *how do these social agents affect children's perception over long-term interactions?* Few studies have explored children's perception of a robot which seems to be pertinent in child-robot interaction [2, 4].

In order to understand children's perception of a social robotic agent, we developed an autonomous system which provides a child-robot educational scenario to improve children's handwriting skills. The system is employed with the *learning-by-teaching* method and was tested by conducting a long-term study with children in a school. In this article, the preliminary results of the study concerning children's perception of the agent's abilities and behavior are briefly discussed.

2. SYSTEM

The experimental setup consists of a child performing a collaborative writing activity with an autonomous Aldebaran Nao robot[1], as shown in Fig. 2(b). In the scenario, the teacher-child and the learner-robot shared a touchscreen with a writing application having several interactive features: the learner-robot writes a deformed letter and asks the teacher-child to correct it. The teacher-child then corrects the letter and demonstrates a correct sample of the same letter on the other side of the screen.

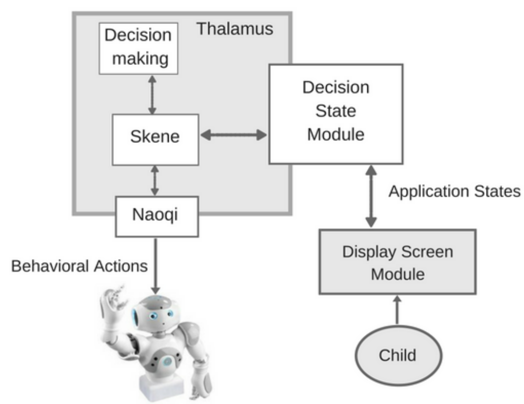

Figure 1 System Architecture

To generate the deformed letters for the robot, we aimed three common handwriting issues prevalent in children: *proportion*, *breaks* and *alignment* which were also suggested by other researchers [1]. To handle the *proportion* and the *breaks* issues, we used an algorithm which has the ability to learn and synthesize the multiple-mode motion trajectories including their rapid extraction and representation [8]. The algorithm supports the human movement inspired features and generates well-formed and deformed sample of letters.

As shown in Fig. 1, the system architecture was composed of several modules. The *display screen module* incorporates the writing application along with the algorithms and letter

[1]Aldebaran robotics: `https://www.aldebaran.com/en`

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trajectories. Each interactive feature (letter screen, button, small writing box, slider) present in the writing application refers to a state. When a child interacts with these states, the current state is send to the *decision module* which decides the robot's action based on the received state. The decision module then sends this information to the robot by using the *Thalamus* framework [6], *Skene* [7] and *Naoqi API* (provided by Aldebaran). In the system, Thalamus provided a high-level integration framework for modularizing the robot and supported asynchronous messaging among wrapped modules [6]. In addition, Skene was used as a semi-autonomous behavior planner that translated high-level intentions originated from decision-making into a schedule of atomic behavior actions (e.g. speech, gazing, gesture) to be performed by the lower levels [7].

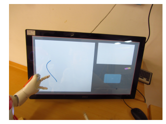
3. STUDY

In order to explore the children's perception towards the abilities and behavior of a robotic agent, the study was carried out under two conditions: *learning* and *non-learning*. In the learning condition, the agent exhibits learning abilities by showing progression in its handwriting skills after each interaction with a child. In the non-learning condition, it does not learn and shows consistent performance, yet still maintains the social aspect, throughout the study. The study consists of between-subjects design and was conducted in a private school "Colégio da Fonte" in Oeiras, Portugal. 25 children participated from the 7- to 9-year-old age group (1^{st} and 2^{nd} grade) over a period of 1 month. Thirteen children participated in the *learning condition* while 12 children participated in the *non-learning condition*. Each child interacted four times with the agent in the gap of 4-5 days and each interaction lasted about 13-15 minutes.

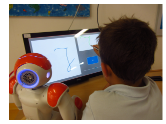
The study was organized into a few steps. In the first step, the researcher would bring a child to a study room and explain the collaborative writing activity including the writing application features. In the second step, researcher would ask the child to perform the pre-test through a tablet application which was specifically developed for the pre-/post-test. On the tablet screen, three shapes of a letter would be displayed and the child would have to select the most correct shape and demonstrate it on the right side of the screen. A set of letters were repeated for the pre-test. In the third step, the child would perform the collaborative writing activity with the robotic agent where the agent would write a deformed letter (see Fig 2(a)) and ask the child for corrections (see Fig. 2(b)). After finishing the corrections, the process was repeated for the remaining letters. Following the interaction phase with the agent, the child would perform the post-test, identical to the pre-test. In the last step, the researcher would ask a few self-response questions by interviewing the child for 10-12 min. The questions were based on 5 point Likert scale and related to the agent's overall performance, writing abilities and his/her fondness towards it. The research questions of the study were: 1) *Would children be able to differentiate the learning abilities of the agent between the conditions?* 2) *Would the learning and non learning competencies of the agent affect children's fondness towards it?*

4. RESULTS & CONCLUSION

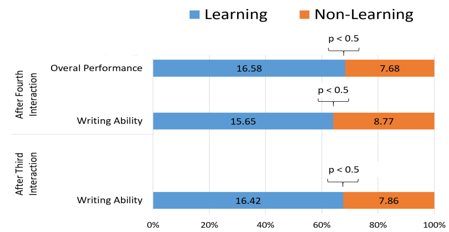
We collected the data from the questionnaire and analyzed it using the non-parametric Mann-Whitney U test which was also suitable for unequal size of the data.



(a)



(b)



(c)

Figure 2 (b) The robot is writing a deformed letter; (a) The child is demonstrating a correct letter; (c) Writing ability and overall performance scores after the third and fourth interaction

The results suggest that the questions related to the agent's learning showed significant differences over time between the conditions. After the third interaction, children in the learning condition (mean rank = 16.42) gave significantly higher *writing ability scores* to the robot compared to the non-learning condition (mean rank = 7.86), $U = 20.5$, $z = 86.5$, $p = .002$ (see Fig. 2(c)). After the fourth interaction, both the *overall performance scores* and the *writing ability scores* showed significant differences between the conditions. Children in the learning condition (mean rank = 16.58) gave higher *overall performance* scores to the robot compared to the non-learning condition (mean rank = 7.68), $U = 18.5$, $z = -3.366$, $p = .001$ (see Fig. 2(c)). For the writing ability, they (mean rank = 15.65) gave higher scores to the robot compared to the non-learning condition (mean rank = 8.77), $U = 30.50$, $z = -2.67$, $p = .015$ (see Fig. 2(c)).

Regarding the children's fondness towards the agent, the results revealed that after the last interaction, more than 92% of the children gave high scores for the fondness and friendliness scale. In addition, in the learning condition, we found a correlation between the likability and the overall performance, $rs(13) = .567$, $p = .043$, and in the non-learning condition, between the friendliness and the overall performance, $rs(11) = .606$, $p = .04$.

Combining the results of the abilities and social behavior of the agent perceived by the children, it suggests that the children did not change their social perception towards the robot despite of being aware of the agent's learning abilities. These results may be useful for other researchers in designing a child-robot educational scenario as it revealed that the capabilities of the agent may not affect child-robot social relationships.

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