A Robot Teaching Young Children a Second Language: The Effect of Multiple Interactions on Engagement and Perfor....

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A Robot Teaching Young Children a Second Language: The Effect of Multiple Interactions on Engagement and Performance

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ABSTRACT

This paper explores the use of a social robot for one-on-one tutoring, in a study in which 15 children participated in four second-language tutoring sessions. Specifically, changes across sessions are measured on two dimensions: engagement and performance. Results have revealed a significant positive change in performance as well as a significant pattern in engagement across the interactions[1].

KEYWORDS

Child-robot interaction, language tutoring, education

1 INTRODUCTION

In recent years, increasing effort is made to design social robots as second language (L2) tutors [1-2]. The potential for robots to be effective tutors comes from various aspects, including their ability to tutor one-on-one [3], and to interact with children over multiple sessions for a longer period of time. However, most L2 learning studies thus far involving one-on-one tutoring lasted only one session [4], while those that have carried out long-term studies allowed one-on-many tutoring [2]. The current study explores the effects of a robot tutor over multiple child-robot L2

tutoring sessions. Specifically, this study investigates potential changes in two dimensions: children's engagement and their performance during the tutoring sessions.

2 OUR APPROACH

This study has been carried out as an extensive pilot study as a part of the L2TOR project, which aims to develop a robot tutor that helps young children learn an L2 [5]. To explore the changing relation between child and robot over the course of multiple one-on-one tutoring sessions, we conducted an experiment that consists of four sessions. During these sessions, the robot taught English (L2) vocabulary to Dutch (L1) children (age 5-6). Specifically, we examined performance and engagement. Performance has been measured as the degree to which children managed to complete tasks during the sessions and a word-knowledge task during a post-test. Task engagement has been measured as the degree to which children are actively involved in the tutoring session. This way, the current study explores how performance and engagement change over time. Based on findings by previous studies [4-7], it is expected that engagement will decrease over the course of the sessions. However, children's performance on the tasks will not be affected, as children will likely become more relaxed and familiarized to the robot and the task setting over time.

3 METHODS

The participants were 15 Dutch children (5 girls and 10 boys) with an average age of 5 years and 6 months (SD = 4.6 months). All parents gave their consent. The experimental setup contained a SoftBank Robotics NAO robot, which interacted autonomously with the child in four L2 tutoring sessions. Prior to the sessions, an introduction session was organized at the school to introduce the robot to the children. During the first three sessions, the robot taught the children a total of 17 words related to math such as numbers, adjectives (e.g., big) and verbs (e.g., add), via several games that the child and the robot played together on a Microsoft Surface Pro 4. The fourth session was a recap lesson to repeat and consolidate all 17 target words. In all sessions, the robot had the role of a peer-tutor, that is, the child and the robot

together played games on the tablet and 'learned' the words. At the end of each session (except for the recap lesson), the child had to complete a task. During this task, several items appeared on the tablet and the robot asked the child to tap on a specific item on the screen to which it referred in L2. The robot automatically logged children's answers to measure their performance on the tasks. In addition, to measure overall improvement of the child's English skill, a pre-test and two post-tests were administered. The pre-test was administered right before the first interaction. One post-test was completed immediately after the recap lesson and the other a week later. In these tests, we asked the children to translate the 17 target words from English to Dutch. The experiments were recorded using a camera. The changes in performance over the course of the sessions were measured by comparing the scores on the tasks that were completed at the end of each of the three learning sessions (the recap lesson did not contain a task part and was not included in this measure). In addition, the scores on the pre- and post-tests were compared to assess the child's knowledge of the target words. To measure changes in engagement over the course of the sessions, a perception study was conducted. Eleven participants (Mean age = 25, SD = 2.8) rated the task-engagement of children on a five-point differential scale for a total of 117 short video clips (5 seconds) without audio (2 per child per lesson, 3 videos were missing due to technical difficulties). A high degree of interrater reliability was found between the participants of the perception study. The average measured ICC was .886 (F(116, 1160) = 8.74, p <.001). The fragments were taken at specific moments in the robot's script, the first a few minutes after the start and the second a few minutes before the end of the lesson.

3 RESULTS

On average, scores on the immediate post-test (M = 3.64, SD = 3.08) were higher than scores on the pre-test (M = 2.43, SD = 2.41), but this difference was not significant ($Mdif$ = 1, t(14) = 1.46, p = .165). The scores on the delayed post-test (M = 4.21, SD = 3.14) were significantly higher than the scores on the pre-test ($Mdif$ = 1.79, t(13) = 2.29, p = .039), indicating that children's knowledge of the target words improved over time (max. possible score: 17). To test the relation between the amount of sessions with the robot and performance on the tasks and engagement, a one-way repeated measures ANOVA was performed for both dependent variables. For performance, the overall ANOVA was significant (F(1,14) = 22.65, p < .001, η2 = .72), revealing a significant effect of session on performance. Performance increased between the first (M = 0.64, SD = 0.35) and second lesson (M = 1.40, SD = 0.46) ($Mdif$ = 0.96, p < .001), but not between lesson two and lesson three (M = 1.39, SD = 0.24) (max. possible score: 2). For engagement, the overall ANOVA was also significant (F(1,14) = 4.61, p = .014, η2 = .02), revealing a significant effect of session on engagement. No significant change was observed between the first (M = 3.55, SD = 0.46) and second lesson (M = 3.64, SD = 0.36). Engagement decreased between the second and third lesson (M = 3.09, SD = 0.63) ($Mdif$ = -0.55, p = .034), and increased between the third and

fourth lesson (M = 3.62, SD = 0.62) ($Mdif$ = 0.53, p = .039) (max. possible score: 5).

4 CONCLUSIONS

In this study, we carried out an extensive pilot to study long-term effects of L2 tutoring using a social robot. Results have revealed a positive relationship between time spent with the robot and performance on the learning tasks. Children improved their learning achievements after spending more time with the robot, possibly because they get more used the robot as a tutor. However, we cannot know this for sure as the content of the individual lessons might have influenced the performance. Furthermore, results showed a decrease of engagement between the second and third session and an increase of engagement between the third and fourth session. The downward trend may be explained by familiarization with the robot. The positive change between the third and fourth session may have been caused by the content of the recap session being different from the three learning sessions or by the fact that children knew that it was the last time they got to play with the robot. While more extensive studies on changes in performance and engagement in longitudinal one-on-one tutoring need to be conducted, this explorative study has thus taken first steps and found promising results regarding how performance and engagement evolve over time in long-term child-robot L2 tutoring sessions. Moreover, this study has set the stage for a larger evaluation study planned in the near future involving more lessons, more children and different conditions.

Acknowledgements

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