Talk, Listen and Keep Me Company: A Mixed Methods Analysis of Children's Perspectives Towards Robot Reading Companions

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ABSTRACT

The potential for robots as an education support tool is being rapidly realized. However, much of the existing research with education robots has involved studies which arbitrarily select robots for interventions without a foundational understanding of the features that make them best suited to serve and meet the expectations and needs of users. This study explored how children's perceptions, expectations and experiences were shaped by aesthetic and functional features during interactions with three different, commercially-available robot 'reading buddies'. We collected a range of quantitative and qualitative measures of subjective experience before and after children read a book with a robot of their choice. Overall, our findings indicated that social robots do indeed show strong potential to promote reading engagement in children. This was supported by robot features that signaled the perception of robots as intelligent, literate and attentive. Such features included the robot's ability to speak and react to the story plot in a way that was both emotionally- and temporally-appropriate, so as to engage but not distract children when reading. As such, controlling the timing of robot animations during reading activities – either using human-control methods or automation – presents a key challenge in realizing the effective deployment of robots to promote reading engagement in children, particularly for those who experience reading difficulty and associated reading anxiety.

CCS CONCEPTS

• **Human-centered computing** → *HCI design and evaluation methods*; *Empirical studies in HCI*; • **Applied computing** → *Psychology*.

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KEYWORDS

social robotics, technology-assisted education, reading, first impressions

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1 INTRODUCTION

The past 15 years have seen growing confidence and interest in the potential for social robots to support children's education, with a large body of research already evaluating the use of robots in various education support roles[1]. However, most studies evaluating education robots have neglected to carefully examine the fundamental features that make them more or less effective, given the needs and expectations of learners and in a context specific way. Closely examining why and how particular robots can facilitate learning in different contexts is important given the high degree of variability across the types of robots used in education, the roles they play during learning, and the type of learning they support [3, 8]. The current study aimed to explore how children's initial perceptions of three different, commercially-available robots (NAO, Cozmo, MiRO), shape their reading experiences and expectations within the context of reading, to explore whether these robots have the potential to promote reading engagement.

2 METHOD

2.1 Participants

Thirty children participated in this study (M age = 8.51 years, SD = 1.74; 11 females; 67% Caucasian, 33%& Asian). The children had no known history of reading difficulty or anxiety and were screened on reading fluency (TOWRE-2)[9] and parent report measures of reading anxiety (MORAT-P)[4] and social anxiety (SPENCE-P)[7]. Only one child reported having prior exposure to one of the robots, but selected a different robot to complete the reading activity with in this study.

2.2 Procedure

A bespoke web-based application was developed to gather subjective responses from children. This enabled children to rank (Figure 1A) and rate (Figure 1B) the robots using an intuitive visual response format. A full depiction of the survey questions and application, as well as all data and analysis code is available on the Open Science Framework (OSF; osf.io/jdv2y/).

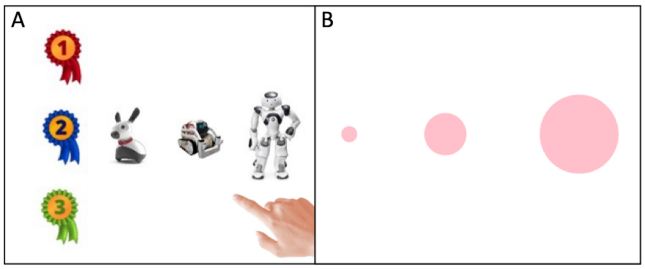

Figure 1: App display for child responses. (A) Robot preference ranking display screen (B) Visual rating scale.

Upon entering the laboratory, children were introduced to the three robots which were placed, inactive, on a small podium (Figure 2A) and ranked the robots according to their preference (Figure 1A). They then watched three short videos of each of the robots performing a simple action (rolling a ball off a table) followed by an appropriate reaction. Videos depicting all animations are available on the project's OSF page (osf.io/jdv2y/). Videos were displayed in random order and showcased the robots' functional differences, such as NAO's ability to walk and talk, and Cozmo's ability to show emotional facial expression. Children then rated each robot on its perceived intelligence and friendliness using a visual rating scale (Figure 1B) and again ranked the robots by preference (Figure 1B). Children then selected one robot to read a short book with.

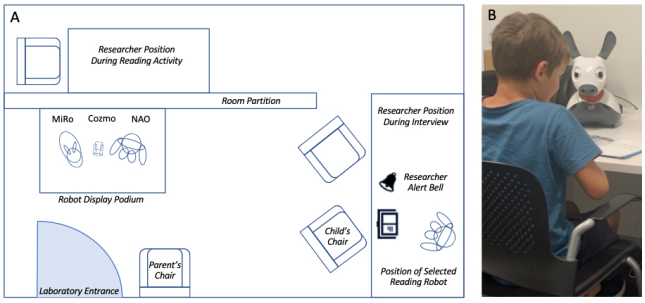

Figure 2: (A) Schematic depiction of laboratory layout. (B) Photograph of child model reading with the MiRo robot.

During the reading activity, the child sat at a table with the selected robot only (Figure 2B), and the experimenter retreated to an unseen location behind a room partition. Children were told that the experimenter would be completing some work with headphones on and were instructed to ring a bell on the table to notify the experimenter once they were finished. Children read the story aloud and the robot reacted to several pre-determined plot points during the story with appropriate emotional responses and vocalizations, controlled using a Wizard-of-Oz (WoZ) approach. Code for our WoZ application is available on GitHub (github.com/gimait/readingtorobot_app & github.com/chaudhuryB/ReadingToRobot) and a full set of videos depicting the animations used for each robot is available on the project's OSF page (osf.io/jdv2y/). The reading activity was followed by a structured interview comprising several rating items as well as open-ended questions that probed the child's experience and perceptions of the robots while reading. Children were also asked to share which capabilities they believed an ideal robot reading companion should have. Interviews were transcribed and then analysed using an inductive thematic analysis approach [2].

3 RESULTS AND DISCUSSION

Preference rankings from children indicated an overall preference for the NAO humanoid robot, followed by the Cozmo mechanoid robot, and then the MiRo zoomorphic robot (Figure 3). Whilst preference trends remained stable, 47% of children changed their preference rankings after viewing the videos of the robots in action, indicating that both aesthetic form and functional capabilities shape initial impressions of robots.

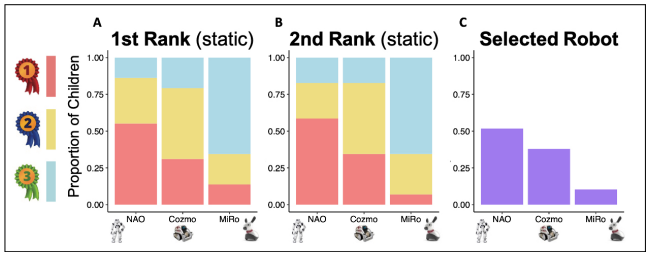

Figure 3: Bar graphs depict the proportion of children who ranked each robot in each place, i.e., 1st, 2nd, 3rd, (A) immediately upon viewing the inactive robots and (B) after viewing the short video demonstrations of the robots in action. Panel (C) summarizes the proportion of children who selected each robot as their reading buddy.

First impression ratings also favoured NAO, as children were more likely to characterise this robot as both friendly and intelligent (Figure 4). Specifically, whilst ratings did not significantly differ across robots for friendliness ($\chi^2(6) = 6.62, p = .357$), significant differences were seen for intelligence ($\chi^2(6) = 15.09, p = .020$), with NAO outperforming both Cozmo and MiRo. This was likely driven by the robot's capacity to communicate verbally, as depicted in the videos shown to children (also see Thematic Analysis Theme 3.1). These robot perceptions are especially critical if reading robot companions are to be used to support reading engagement for children with reading difficulty. A reading companion that is competent yet non-judgmental is important given that these children are more likely to experience reading anxiety and social anxiety; characterised, in part, by a fear of being negatively evaluated by others while reading [5, 6].

Our thematic analysis identified several opportunities and challenges associated with using social robots to promote reading engagement. Children explained that robots can provide them with

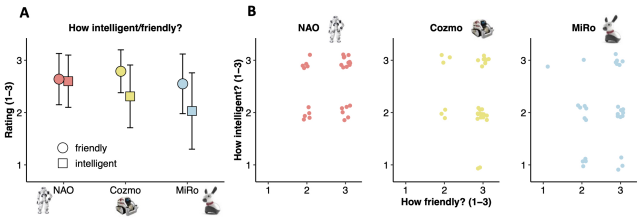

Figure 4: (A) Mean ratings for 'How intelligent' and 'How friendly' children found each robot to be after viewing demonstration videos. (B) Scatterplot summarizing the relationship between individual ratings of Intelligence and Friendliness for each robot.

an engaging and non-judgmental social context that motivates continued reading (Theme 1.1). This was supported by children's perceptions of robots as being intelligent enough to read, listen and comprehend a story, particularly when the robot demonstrated the capacity to talk (Theme 3.1). Robot animations and responses during reading were key in driving this engagement (Theme 2.1). Children explained that this encouraged reading by animating the story, increasing the feeling of being attended to (Theme 2.2), and inspiring curiosity about how the robot will react next. Some children went further to explain how the robot reactions supported their comprehension of the story by confirming their interpretation of the story line whilst making it more memorable (Theme 2.4). However, children also indicated that unpredictable or mistimed reactions had the potential to distract (Theme 2.3). A comprehensive analysis, as well as a summary of quotations organised by sub-theme and associated robot and child demographics can be found on the project's OSF page (osf.io/jdv2y/).

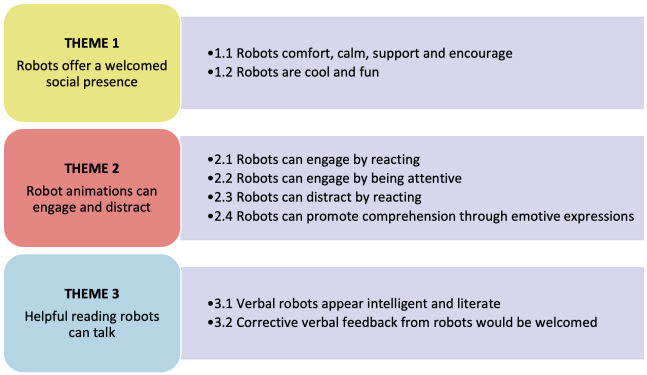

Figure 5: Summary of thematic analysis themes and subthemes.

4 CONCLUSION

Children's subjective experiences of reading with robots suggest great promise for the application of social robots to support children's reading engagement. However, for the full potential of reading robots to be realised, technological strides in developing autonomous robots that have highly sensitive and accurate speech recognition – for both correct and incorrect pronunciations of regular and irregular words – is needed, to ensure they can respond to children in an appropriate and timely way. This is also key if robots are to additionally provide children with corrective feedback when it is both needed and wanted; another capability that children indicated they would appreciate and expect of a robot reading companion (Theme 3.2). More broadly, we demonstrate that much is to be gained by directly inviting children to share their perspectives when developing and deploying social robotics in education contexts. This offers the opportunity to identify the robot features that are likely to help and hinder children when learning alongside artificial companions. We are currently expanding this work to explore the specific expectations, experiences and needs of children with reading difficulty and anxiety.

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