Evaluating the effects of humanoid robots on the story retelling skills of children on the autism spectrum

EXECUTIVE SUMMARY

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The Commonwealth Scientific and Industrial Research Organisation (CSIRO)

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The Cooperative Research Centre for Autism (Autism CRC)

The Cooperative Research Centre for Autism (Autism CRC) is the world's first national, cooperative research effort focused on autism. Taking a whole-of-life approach to autism focusing on diagnosis, education and adult life, Autism CRC researchers are working with end-users to provide evidence-based outcomes which can be translated into practical solutions for governments, service providers, education and health professionals, families and people on the autism spectrum.

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A note on terminology

We recognise that when referring to individuals on the autism spectrum, there is no one term that suits all people. In our published material and other work, when speaking of adults, we use the terms 'autistic person', 'person on the autism spectrum' or 'person on the spectrum'. The term 'autistic person' uses identity first language, which reflects the belief that being autistic is a core part of a person's identity.

Autism Spectrum Disorder (ASD) is diagnostic terminology used by the healthcare sector and is used in the context of a person being 'diagnosed with Autism Spectrum Disorder'.

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Executive Summary

Purpose of this study

The current pilot study evaluated the effects of using a humanoid robot to help develop the perspective-taking skills of school-age children on the autism spectrum during story retelling. This current pilot study expands the use of humanoid robots to support story retelling for students on the autism spectrum. Outcomes of the study include a teacher guide to support schools and teachers interested in using a humanoid robot to support story retelling. This guide can also be used without a humanoid robot as the retelling of the story and the modelling of the language can be done by the teacher.

Aim of the study

The aim of this study was to develop evidence-based guidelines for teachers on the use of humanoid robots to foster narrative perspective-taking in children on the autism spectrum. The study had the following specific objectives:

- To identify and evaluate effective strategies that strengthen story retelling for children on the autism spectrum.
- To create and apply story retelling scripts for appropriate use with humanoid robots with children on the autism spectrum, during sessions facilitated by their teachers.
- To assess changes in the narrative perspective-taking ability of children on the autism spectrum, as reflected in their ability to retell a story from different perspectives following the story retelling sessions.

The outcomes from this study include a literature review, robot scripts, and a guide for teachers and schools planning to implement story retelling sessions for supporting story retelling learning activities and perspective-taking with children on the autism spectrum. The outcomes from this study also address the main research question:

Research question

What are the potential impacts of using a humanoid robot as a tool to support social perspective-taking and internal state language use with students on the autism spectrum?

Research design

A mixed-method sequential explanatory two-phase design (Creswell, 2009) was used in this study. This two-phase design is useful for gaining an in-depth understanding of quantitative data through the collection of qualitative evidence.

Data analysis

Data from the robot-assisted sessions (Group A) and the teacher interview for Teacher A was collected in September 2019, while data from the control group (Group B) and Teacher B was collected in June 2021. Children's narrative retellings before and after the sessions were evaluated for perspective-taking and use of internal state language. Each narrative language sample was evaluated using a perspective-taking score and total number of internal language terms used. Additionally, all story retelling sessions were video recorded to collect and analyse students' narratives in the story retelling tasks.

Key findings

Key findings of this pilot study, evaluating the effects of a humanoid robot on the story retelling skills of children on the autism spectrum, are as follows:

- No significant changes were observed in students' social perspective-taking following the completion of the teaching program in both groups.
- No significant changes were found in students' use of internal state language after the teaching program in both groups.
- The expectations teachers have about using a humanoid robot need to be addressed prior to commencing using the robot in the classroom. Students' expectations also need to be managed.
- The robot helped keep students engaged with the repeated reading of the story.
- The teacher guide and session scripts were seen as important for helping scaffold the story retelling sessions. The scripts, and the robot, helped model the language needed for the retellings.
- The character and perspective-taking maps were considered as beneficial for scaffolding students' retelling of the story from a character's perspective.
- The Story Braids were the most effective strategy used and were seen as the easiest to transfer to a classroom context.

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Limitations

Limitations of this pilot study include:

- The delay in the recruitment of School B due to restrictions caused by the COVID 19 pandemic. This also caused delays in the recruitment of teachers and students for the study.
- The small sample size, of two groups of 5 students, from two different schools, limits the ability to generalise the results. Further research would need to explore if the results from this study can be replicated.
- The teachers also present a limited data set but do show a representation of their perceptions after being involved in this study.
- Two different teachers, with different skills, conducted the sessions in each school. As such, it is difficult to identify the impact the different teaching styles could have had on the outcomes.
- The lack of follow up data to evaluate whether students' social perspective-taking and use of internal state language have been maintained after the completion of the teaching program. This phase has not been implemented as planned, due to COVID-19 restrictions on school operations.

Implications

Implications for Future Research

This study can inform the use of humanoid robots for narrative story retelling with students on the autism spectrum. Further research on social perspective-taking and internal state language with children on the autism spectrum through group teaching programs delivered by teachers is required to uncover the learning process for individual students and how they engage with their teacher and their peers in these sessions. Further studies are also necessary to explore the variety of strategies used by the teachers in the story retelling sessions, including the story retelling session guides and scripts. The effectiveness of the teacher session guides and scripts could also be examined in other curriculum contexts and on a larger scale.

Implications for Future Practice

Implications for future practice include:

- Making the session guides and scripts, developed for this study, available for teachers and schools, interested in using humanoid robots for supporting story retelling with children on the autism spectrum.
- Providing guidelines applied in this study, to teachers and school staff interested in the use of visual supports (such as the story braid) to scaffold story-retelling covering key parts of the story structure for small group instruction.
- Providing exemplars of activities and rubrics for evaluating the individual use of internal state language in story retelling and written activities (e.g., character and perspective-taking maps).
- Professional Development (PD) for teachers to discuss expectations and to provide an overview of the teacher guide, scripts, and strategies used in the story retelling sessions.

Key Recommendations

Not only will this study contribute to existing practices in the fields of autism education and educational robotics, but it also has implications for future research and practice. Developing teacher capacity to use assistive technologies (in this case educational robots) and the use of guides and scripts will expand teachers' existing practices for supporting students on the spectrum in their story-telling and social understanding.

This study has generated new knowledge on the use of humanoid robots for story retelling and social perspective-taking skills with students on the spectrum. It also contributes to the research about the use of NAO Robot with children on the autism spectrum and can be used to inform future research into additional attributes of the robot that could contribute to improved learning and generalisation of skills.

Even though teachers in both groups were provided with scripts, it would be interesting to explore their spontaneous use of mental state language in their references to the story characters' mental states and the instances of positive and corrective feedback to help every student in their group complete the perspective-taking maps for the story characters and retell the story using the Story Braid.

Project findings can guide participating schools and teachers using humanoid robots to supporting story retelling with children on the autism spectrum. Other teachers, and students on the spectrum, might also benefit.

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Our values

Inclusion
Working together with those with the lived experience of autism in all we do

Innovation
New solutions for long term challenges

Evidence
Guided by evidence-based research and peer review

Independence
Maintaining autonomy and integrity

Cooperation
Bringing benefits to our partners; capturing opportunities they cannot capture alone

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