Creating vignettes for a Robot-Supported Education Solution for Children with Autism Spectrum Disorder

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Abstract. As part of the work in developing a robotic toolkit to help children with ASD develop their social and communication skills, we have adapted a method for creating vignettes that has been fruitful in other studies. We present a brief background of earlier work that has been done with robots and children with ASD, the idea behind our toolkit, and how we have involved the different stakeholders so far. We then present our updated method for creating vignettes and how we plan to run our workshops. We close with discussing some current challenges and next steps.

Keywords: robot, human-robot interaction, autism spectrum disorder, children, education

1 Introduction

Autism Spectrum Disorder (ASD) is characterized by poor nonverbal conversation skills, uneven language development, repetitive or rigid language, and narrow inter-ests in specific areas. Many children with ASD have difficulty understanding body language and the meaning and rhythm of words and sentences. Developing social interaction and communication skills can be challenging, but these skills form the basis for the children's future opportunities, degree of independence, and quality of life. Language skills are vital for education, expressing needs, and participating in society and work life [18].

The current recommendations for programs targeting communication skills of children with ASD should: (a) begin at preschool and continue through school; (b) be tailored to the child's age and interests; (c) address communication and behavior; and (d) offer regular reinforcement of positive actions [6, 17]. These programs often require special educators and teacher aids. Information and communication technology (ICT) resources may increase the quality of the children's support and reach additional children with ASD. We are currently working on a tool to support language development of children with ASD using social robots. Social robots interact with people in a natural, interpersonal way, and socially assistive robotics (SAR) assist people by using a robot for social interaction (speech, gestures, and body language) [15].

There were several good reasons for selecting robots to help children with ASD. Robots can elicit motivation and provide physical presence and a more tailored experience than other ICT solutions [1]. Robots can provide teachers with new tools [12] and deliver predictable behaviors and repetitive feedback. In addition, a robot can help build social behavior skills, teach, or demonstrate socially desirable behaviors to children with ASD who have trouble expressing themselves. Robots do not get angry, tired, or stressed, and they can be tailored to the needs of a specific child and used repetitively [10]. A child-sized or smaller robot is less intimidating than adults, and many children with ASD therefore feel safer interacting with social robots [15]. Children with ASD who had trained with robots paid closer attention during interactions with adults long after the robot training ended [15], and children with ASD were more likely to complete a treatment session when the session included a robot [23]. Other studies reported improved social skills, increased involvement, more positive behavior, and better social interaction [10, 5, 14, 20].

A review of robots in ASD interventions defined four categories of intervention goals: social, communication, maladaptive behavior, and academic skills [1]. Most studies, however, target only one of these goals, and they normally target only one kind of social robot. Research is needed on how social robots in general can meet the challenge of targeting all or a combination of the goals, in particular combining supporting social skills with language learning. Robots have been shown to be effective in teaching knowledge and skill-based topics, but research is needed on how effectively they teach language [2, 13]. To our knowledge, there are no studies of robot-supported development of primary language skills for children with ASD nor any attempt to make the lessons work on multiple kinds of robots. To develop robots in this field, technological and multidisciplinary research is needed in human-robot interaction (HRI), human-computer interaction (HCI), robot-assisted learning, privacy, and ethics.

Our overall objective is to use social robots to improve language, social, and communication skills for children with ASD. We plan to do this by researching how to best apply a robot for this activity by involving teachers, parents, and children in the design process, and to develop a toolbox that the teachers can use to personalize lessons for children with ASD. To meet this objective, we need to understand what possible scenarios work well for teaching children in this diverse group using a robot.

This paper introduces the ROSA toolbox (Section 2), discusses some other studies in the area (Section 3) and describes on our present research activity of determining the use cases for teaching, and how to involve the children, parents, and teachers (Section 4). We also document the process for finding vignettes in our current workshop and how it has been adapted it from other contexts to the context of a robot in the school (Section 5). We end with discussing challenges and next steps in our research (Section 6).

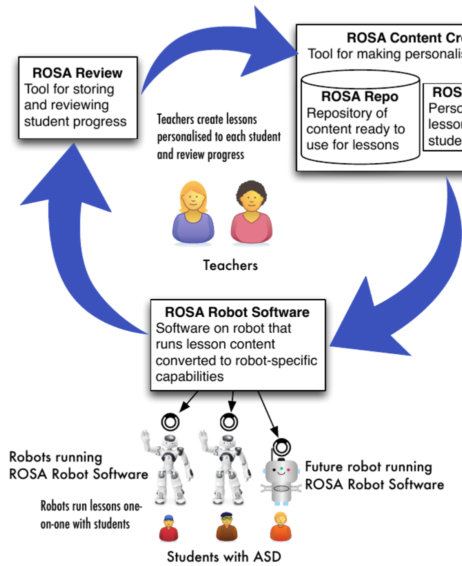

Fig. 1. The ROSA Toolbox consists of three parts: a content creator, software that runs on the robot for interpreting the lessons, and a review panel for teachers.

2 The ROSA toolbox

To help meet our objective, we are working on building the RObot Supported Education for children with ASD (ROSA) toolbox. The toolbox consists of three parts (Fig. 1): (*a*) ROSA Content Creator, a tool for easily creating tailored one-on-one lessons for children with ASD; (*b*) ROSA Robot Software reads the lessons and runs lesson content customized to the robots capabilities; and (*c*) ROSA Review, a tool for following lesson progress and input for the next lesson. The goal of the toolbox is to make teachers more effective by providing tailor-made education plans for children with ASD and easy to follow progress. For children with ASD, the toolbox lessons will be tailored to their unique needs, increase the children's motivation for learning and result in children developing better language, social, and communication skills. The robot will present content customized to the robot's capabilities. We posit the ROSA toolbox can provide tailored, motivating educational and communication support by exploring and exploiting the unique affordances of a social robot as an expressive medium and educational tool for children with ASD.

3 Other studies using robots with children with ASD

The ROSA toolbox is not the first study to look at how to incorporate a robot with teaching children with ASD. A current question we are examining is the role of the robots in the lessons and what sort of motivation mechanisms that can be used to hold engagement of the children and motivate them to continue. We have examined how other research has used robots. For example, robots have been used to help develop sensory experiences for children with ASD [11]. In this study, a robot helped the children experience a senses at different stations. This study found that the humanoid robot was more engaging than a wheeled robot.

An earlier review on the clinical use of robots for people with ASD was critical about the use of robots because many of the studies were only exploratory and the results normally were only ever published in robotics journals and not journals about ASD [7]. Some studies since then have attempted to be more grounded in ASD research (e.g., [23]) and be over longer periods of time (e.g., [22]).

Others have used robust robots to help children with ASD experience things through play [3]. In this situation, it was very important to create a robot that could be built cheaply, robustly, big enough to be hugged and touched, and run for long periods without maintenance. The created robot (TeoG) was successful and able to stand up to children tackling and hugging the robot in the play sessions. Others have gone further and developed qualitative and quantitative requirements for using touch with robots and children with ASD [4]. Care must be taken, however, as some children with ASD seek out touch, while others avoid it. Regardless, the therapists involved in designing the guidelines argue that touch would be useful regardless of the role the robot played (e.g., teacher, friend, companion); although there was no agreement on the shape of the robot [4].

Some studies have used educational games [24, 19, 23] that have been good for teaching concepts and improving skills, such as turn-taking, social interaction, self-initiation, and understanding other people's perspective. In one of the studies, the robot was only used for part of a therapy session, but the children reported liking the *whole* session better (i.e., not just the parts including the robots) [23]. Regardless, of how the robot is used, technical issues need to be addressed as well. Some solutions can be having a second backup robot [19] or ensuring that the robot is responsive to the actions that happen from the child [23]. Using *Wizard of Oz* techniques may address these issues in the short-term, but are likely expensive in the long term.

4 Involving children, parents, and teachers in the creation process

To ensure success of the ROSA toolbox, we are working closely with a school that specializes working with children with ASD and other cognitive disabilities. We have visited the school on multiple occasions and observed how different classes teach the children. These observations were useful for understanding the range of abilities of the children in the school.

We have also held meetings with teachers where we have presented the goals of the project and previous work that has been done in the area (e.g., from Mengoni et al. [16]). We also asked teachers to anonymously answer a questionnaire about what they thought about possibilities for using a robot in the classroom. This included questions like what feelings would be raised in the children, if the robot can help children with developing language or communication skills, other social skills, and if the robot could help in maintaining motivation, attention, joint attention, and concentration. We also asked the teachers if the robot should be used in groups or individually.

We also had the robot come to visit a couple of classes. There were also a couple of sessions where the robot ran a program that was developed for a different target group [8], but could still be useful for communication in some classes. The visits were useful from a technical standpoint as it highlighted a variety of technical issues that would need to be solved to make the robot work seamlessly in the classroom.

One activity we devised for understanding the context was to have the teachers work together with the researchers to develop vignettes of activities that could serve as the basis of one or more lessons.

5 Finding vignettes

Vignettes are small, self-contained, reusable, temporarily ordered set of events that can be put into multiple scenarios [21]. The scenarios here in this case would be the in the potential lessons created by the ROSA content creator and run in the ROSA robot software. This requires cooperation from teachers as the experts in understanding the children's needs.

Our method for finding vignettes is based on a technique that we have used in other projects [9]. The goal is to gather groups of local experts in a workshop with the goal of vignettes as an output from the workshop. The local experts work together on a worksheet that list the necessary bits that form the building blocks of the vignette. From experience, having experts that understand the context and the goal has led to developing many vignettes in the very short time the workshop was run [9].

Since this technique can be used in different context, the different items on the worksheet are dependent on the context being worked on. Since the context here is children with ASD in school and the local experts were teachers, the items in the worksheet were adjusted to use pedagogical and work terms that the teachers were familiar with.

Our categories of items included:

- Purpose
- Selected goals and tasks from previous work
- Student's or students' skill level
- Learning prerequisites
- Digital learning environment
- Amplifier or reward
- Prompts that can be given
- Learning outcome
- Other

The workshop will be run as part of a larger two-day pedagogical workshop at the school. The workshop itself is split into a section for both days. On the first day, the ROSA toolbox will be explained and some of the different technologies that we are working with will also be explained. We will then introduce them to the basics of the workshop, introduce the categories, and show the groups for the activities for the next day. We have worked with the administration before the pedagogical in the school to split up the teachers into groups where they had similar levels of students. In addition, each group will have an explicit area of focus (for example, part of a specific curriculum or technology) to help anchor the vignette finding.

On the second day, the teachers will work in the groups introduced from the previous day to come up with as many vignettes as they can in a 90-minute period. Since there will be more groups than researchers, researchers will switch between groups to help keep the groupwork on track. After the 90-minute period is up, everyone will return and summarize their results from each group.

6 Challenges and next steps

The vignettes will provide a starting point on creating scenarios and content that can be added to the ROSA toolbox. We plan on putting together a early prototype that can be used before summer or in the start of the next school year.

The teachers that answered our survey indicated that the children would probably be likely excited and skeptical to a robot in the classroom. They also were unsure how well the robot would work in the classroom, but were positive to finding out how this could work.

The robot visits in the classroom drew interest from the children. The robot seemed to capture the children's attention, although some were uncertain of the robot. Unfortunately, due to illness we were unable to complete the visits to all the classes we wanted, but we hope to resume this later, perhaps with some of the vignettes we are working on.

The visiting robot also uncovered many technical issues with the robot, network connections, and the software. The biggest issues was connectivity; it turns out that the connection between the robot, the software, and offsite cloud service was more fragile than anticipated. This led to many issues in having the robot not function as expected, but it was good feedback to use for future iterations of the software. Making the technical issues disappear is important as our observations and feedback from the teachers indicates that if the robot does not work as expected, children will not be draw motivation from the robot, and it won't be used.

Also, the COVID-19 pandemic still causes issues in schools with unexpected sick leave and potential closing of schools. Our partner school has been very flexible and robust, so this has been less of an issue so far than was initially anticipated. We continue monitoring the situation to ensure that risks of infection remain low.

Acknowledgments This work is partly supported by the Research Council of Norway as part of the RObot Supported Education for children with ASD (ROSA) project, under grant agreement 321821. We would also like to thank the other project members, and a special thank you to the teachers and students at *Frydenhaug skole* for their participation in the project.

References

1. Begum, M., Serna, R.W., and Yanco, H.A.: Are Robots Ready to Deliver Autism Interventions? A Comprehensive Review. Int J of Soc Robotics 8(2), 157–181 (2016)
2. Belpaeme, T., Vogt, P., Berghe, R. van den, Bergmann, K., Göksun, T., Haas, M. de, Kanero, J., Kennedy, J., Küntay, A.C., Oudgenoeg-Paz, O., Papadopoulos, F., Schodde, T., Verhagen, J., Wallbridge, C.D., Willemsen, B., Wit, J. de, Geçkin, V., Hoffmann, L., Kopp, S., Krahmer, E., Mamus, E., Montanier, J.-M., Oranç, C., and Pandey, A.K.: Guidelines for Designing Social Robots as Second Language Tutors. Int J of Soc Robotics (2018)
3. Brivio, A., Rogacheva, K., Lucchelli, M., and Bonarini, A.: A Soft, Mobile, Autonomous Robot to Develop Skills through Play in Autistic Children. Paladyn, Journal of Behavioral Robotics 12(1), 187–198 (2021)
4. Burns, R.B., Seifi, H., Lee, H., and Kuchenbecker, K.J.: Getting in Touch with Children with Autism: Specialist Guidelines for a Touch-Perceiving Robot. Paladyn, Journal of Behavioral Robotics 12(1), 115–135 (2021)
5. Dautenhahn, K., and Werry, I.: Towards Interactive Robots in Autism Therapy: Background, Motivation and Challenges. Pragmatics & Cognition 12(1), 1–35 (2004)
6. Deafness and Other Communication Disorders (NIDCD), N.I. on: Autism Spectrum Disorder: Communication Problems in Children, NIDCD. (2015). `https://www.nidcd.nih.gov/health/autism-spectrum-disorder-communication-problems-children` (visited on 11/12/2020)
7. Diehl, J.J., Schmitt, L.M., Villano, M., and Crowell, C.R.: The Clinical Use of Robots for Individuals with Autism Spectrum Disorders: A Critical Review. Research in Autism Spectrum Disorders 6(1), 249–262 (2012)
8. Halbach, T., Schulz, T., Leister, W., and Solheim, I.: Robot-Enhanced Language Learning for Children in Norwegian Day-Care Centers. MTI 5(12), 74 (2021)
9. Hannay, J.E., Fuglerud, K.S., Schulz, T., and Leister, W.: Scenario Design for Healthcare Collaboration Training under Suboptimal Conditions. In: 13th International Conference on Digital Human Modeling & Applications in Health, Safety, Ergonomics & Risk Management. Lecture Notes in Computer Science, In–Press. Springer, Gothenburg, Sweden (2022)
10. Huijnen, C.A.G.J., Lexis, M.A.S., Jansens, R., and de Witte, L.P.: How to Implement Robots in Interventions for Children with Autism? A Co-creation Study Involving People with Autism, Parents and Professionals. J Autism Dev Disord 47(10), 3079–3096 (2017)
11. Javed, H., Burns, R., Jeon, M., Howard, A.M., and Park, C.H.: A Robotic Framework to Facilitate Sensory Experiences for Children with Autism Spectrum Disorder: A Preliminary Study. J. Hum.-Robot Interact. 9(1), 3:1–3:26 (2019)
12. Jones, A., and Castellano, G.: Adaptive Robotic Tutors That Support Self-Regulated Learning: A Longer-Term Investigation with Primary School Children. Int J of Soc Robotics 10(3), 357–370 (2018)

13. Kanero, J., Geçkin, V., Oranç, C., Mamus, E., Küntay, A.C., and Göksun, T.: Social Robots for Early Language Learning: Current Evidence and Future Directions. Child Development Perspectives 12(3), 146–151 (2018)
14. Lee, C.-H.J., Kim, K., Breazeal, C., and Picard, R.: Shybot: Friend-Stranger Interaction for Children Living with Autism. In: CHI '08 Extended Abstracts on Human Factors in Computing Systems. CHI EA '08, pp. 3375–3380. Association for Computing Machinery, New York, NY, USA (2008)
15. Matarić, M.J., and Scassellati, B.: Socially Assistive Robotics. In: Springer Handbook of Robotics. Ed. by B. Siciliano and O. Khatib, pp. 1973–1994. Springer International Publishing(2016)
16. Mengoni, S.E., Irvine, K., Thakur, D., Barton, G., Dautenhahn, K., Guldberg, K., Robins, B., Wellsted, D., and Sharma, S.: Feasibility Study of a Randomised Controlled Trial to Investigate the Effectiveness of Using a Humanoid Robot to Improve the Social Skills of Children with Autism Spectrum Disorder (Kaspar RCT): A Study Protocol. BMJ Open 7(6), e017376 (2017)
17. Olaff, H.S., and Eikeseth, S.: Variabler som kan påvirke effekter av tidlig og intensiv opplæring basert på anvendt atferdsanalyse (EIBI/TIOBA). (2015)
18. Parmenter, T.: Promoting Training and Employment Opportunities for People with Intellectual Disabilities: International Experience. (2011)
19. Sandygulova, A., Zhexenova, Z., Tleubayev, B., Nurakhmetova, A., Zhumabekova, D., Assylgali, I., Rzagaliyev, Y., and Zhakenova, A.: Interaction Design and Methodology of Robot-Assisted Therapy for Children with Severe ASD and ADHD. Paladyn, Journal of Behavioral Robotics 10(1), 330–345 (2019)
20. Simm, W., Ferrario, M.A., Gradinar, A., and Whittle, J.: Prototyping 'Clasp': Implications for Designing Digital Technology for and with Adults with Autism. In: Proceedings of the 2014 Conference on Designing Interactive Systems. DIS '14, pp. 345–354. Association for Computing Machinery, New York, NY, USA (2014)
21. Simulation Interoperability Standards Organization: *SISO-GUIDE-006-2018 – Guideline on Scenario Development for Simulation Environments*. 2018.
22. Taheri, A., Shariati, A., Heidari, R., Shahab, M., Alemi, M., and Meghdari, A.: Impacts of Using a Social Robot to Teach Music to Children with Low-Functioning Autism. Paladyn, Journal of Behavioral Robotics 12(1), 256–275 (2021)
23. Van den Berk-Smeekens, I., van Dongen-Boomsma, M., De Korte, M.W.P., Den Boer, J.C., Oosterling, I.J., Peters-Scheffer, N.C., Buitelaar, J.K., Barakova, E.I., Lourens, T., Staal, W.G., and Glennon, J.C.: Adherence and Acceptability of a Robot-Assisted Pivotal Response Treatment Protocol for Children with Autism Spectrum Disorder. Scientific Reports 10(1), 8110 (2020)
24. Wood, L.J., Robins, B., Lakatos, G., Syrdal, D.S., Zaraki, A., and Dautenhahn, K.: Developing a Protocol and Experimental Setup for Using a Humanoid Robot to Assist Children with Autism to Develop Visual Perspective Taking Skills. Paladyn, Journal of Behavioral Robotics 10(1), 167–179 (2019)