# The Huggable Social Robot Probo for Social Story Telling for Robot Assisted Therapy with ASD Children

R. Simut, G. Van de Perre, C. Pop, B. Vanderborght J. Saldien
A.S. Rusu S. Pintea J. Vanderfaeillie D. Lefeber D.O. David

[1]Vrije Universiteit Brussel, Robotics and Multibody Mechanics Research Group, Brussels, Belgium [2] Babes-Bolyai University; Department of Clinical Psychology and Psychotherapy, Cluj-Napoca, Romania [3] Howest University College, Industrial Design Center, Kortrijk, Belgium [4] Mount Sinai School of Medicine, USA [5] Vrije Universiteit Brussel, Department of Clinical and Life Span Psychology Group, Brussel, Belgium - bram.vanderborght@vub.ac.be - http://probo.vub.ac.be

## 1 Introduction

Children with Autism Spectrum Disorders (ASD) experience difficulties to engage in social interaction, and therefore lack learning opportunities in their classrooms and daily lives. Different therapies exist to attempt to lessen the deficits and family distress. Due to the recent advances in personal robots, the technology is becoming in the reach to be used as Robot Assisted Therapy. Hereby, the aim is to use robots as a facilitator [5] that mediates the interaction between the child and the human, and not to replace the human therapist. Emerging research shows, that autistic children proactively approach robots, that robots can act as a mediator between the child and the therapist , that robots can be used for play therapy and to elicit joint attention episodes between a child and an adult [6],[2]. The ability to express emotions is essential in social interaction. Therefore, different ASD therapies, like Social Stories developed by Carol Gray [4], focus on these aspects. Social Stories are short stories written or tailored to individuals with ASD to help them understand and behave appropriately in social situations. This paper discusses the first results of using the social robot Probo as Social Story telling agent for children with ASD. Probo's purpose is to serve as a multidisciplinary research platform for human-robot interaction focused on children. The robot is designed to act as a social interface by employing human-like social cues and communication modalities. With 20 motors in the head, the robot is able to express attention and emotions via its gaze and facial expressions [7]. To guarantee a safe physical child-robot interaction, compliant actuation systems and a layered structured with foam and fabric, are implemented [3].

## 2 Procedure

Two boys (Nicu and Mihnea) and two girls (Antonia and Georgia) participated in the study, aged between 4 to 9. The participants had an independent diagno-

sis of ASD which meets the criteria outlined in the DSM-IV- TR [1]. The study took place at the therapy centre for children with ASD (Autism Transylvania Association, Romania). The robot was operated in a Wizard of Oz setup; using the camera implemented between the eyes of the robot, the operator could make the appropriate actions to respond to the child's behavior. Each child had only one intervention session by day. The stories were developed using Gray's Social Story construction guidelines [4], taking in account the feedback of the parents and therapists. For each of the four participants, a specific social skill deficit was identified. Also, the contextual factors that contribute and/or maintain that deficit were assessed, and the reinforcers for the maintenance and the generalisation of the specific social skill were selected. The Social Stories for Antonia and Nicu were designed to teach them how to share the toys when they are playing together with other children, for Georgia to teach her how to say thank you when someone gives his help to her or shares something with her, and finally for Mihnea to say hello when he enters in a room where someone is present.

To investigate the effectiveness of using a robot as facilitator during ASD therapies, an ABAC/ACAB counterbalanced design was used. In the baseline phase (A), each child was observed during social interactions in order to measure the level of the abilities aimed to be improved by the interventions. During intervention phase (B), the story was read by the therapist, while in (C), Probo told the story. After several sessions of Phase B/ Phase C, the intervention was withdrawn to the baseline conditions and the participants were observed without receiving any intervention. Before the robotherapy phase (C), an habituation phase with the robot was conducted to let the child interact as much as he/she needed. The session of the intervention itself lasted approximately 15 minutes. The Social Story reading was followed by a comprehensive check , which had to be answered with 100% accuracy. Afterwards, the child had to exercise the social ability that was targeted in the story. For example, if the ability targeted was to say hello, the child was brought to a room where is someone present. All experiments were video-recorded and three experienced persons, trained by the experimenter performed the analyses of video sequences from all the phases of the study. The dependent measurement was the level of prompt needed to provide the expected social response and was assessed using a 6-point scale rating the amount of prompting necessary for a successful social interaction. Hereby, 6 indicated that the child did not respond to any prompt (gestural, physical or verbal) and a value of 0 was given if the participant independently and spontaneously engaged in an appropriate social interaction, without the need of any type of prompt. A more detailed description and analysis can be found in [8].

## 3  Data analysis

For each intervention phase, the participants' performance measured by the level of prompt, is presented as box plots in Figs. 1.

**ANTONIA** Fig. 1-Antonia indicates that both interventions were associated with a decreased level of prompt needed to share the toys. However, the robot assisted intervention had a stronger effect on decreasing the level of prompt than the Social Story intervention without the robot. When Probo told the story, only gestural prompts were required to engage Antonia in the appropriate social interaction.

**GEORGIA** Fig. 1-Georgia indicates a better performance of the target behavior during the two intervention phases, compared to the baseline phases. Similar to Antonia's case, compared to the Social Story intervention, the robot assisted intervention appeared to have a stronger effect in decreasing the level of prompt Georgia needed to say thank you. When Probo was used as story telling agent, Georgia was mostly able to said thank you independently and spontaneously, without the need of any type of prompt.

**MIHNEA** The graph analysis in Mihnea's case (Fig. 1-Mihnea) indicates a stronger effect in decreasing the level of prompt in the robot assisted intervention phase, as compared to the phase in which the story was told by the therapist. During Phase C, Mihnea was able to say hello spontaneously in half of the trials. Afterwards, in the second baseline phase A, Mihnea was able to say hello when he entered in a room where someone was present with mostly only gestural prompts.

**NICU** As can be seen in Fig. 1-Nicu, during the baseline phase, Nicu did not respond at all or only responded to the interaction after therapist's full prompt (gestural, physical and verbal). With the robot it was possible to decrease this average level by two points. Compared to the second baseline phase, the introduction of the Social Story intervention (phase B) was associated with a decrease of the level of prompt, but not as pronounced as in the case of robot assisted intervention (phase C).

## 4   Conclusion

The profound impairment in social interaction is considered to be the most important deficit that individuals with ASD experience across their life span. An emerging research field, Robot Assisted Therapy, consists of using social robots in therapeutical contexts for children with ASD in order to improve their social abilities. The social robot Probo was used as a facilitator in Social Story intervention. The results suggest that enriched social environment (the presence of the robot) improved the effectiveness of Social Story intervention, since the average prompt in Phase C is lower than in Phase B. In the robot assisted phase, in 40% of the interventions no prompts were necessary and a spontaneous engagement in the appropriate social interaction was obtained, while this was only 13% in Social Story phase. Future work includes performing more therapy sessions with the robot.
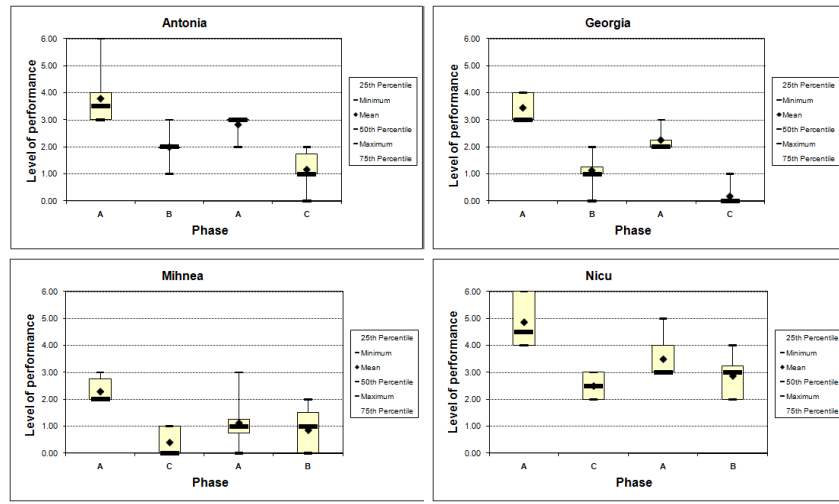
**Fig. 1.** Box plots of the data collected for the four children.

# References

1. American Psychiatric Association and American Psychiatric Association. Task Force on DSM-IV.: Diagnostic and statistical manual of mental disorders: DSM-IV-TR. American Psychiatric Publishing, Inc. (2000)
2. Dautenhahn, K., Werry, I., Rae, J., Dickerson, P., Stribling, P., Ogden, B.: Robotic Playmates: Analysing Interactive Competencies of Children with Autism Playing with a Mobile Robot. Multiagent Systems, Artificial Societies, and Simulated Organizations 3 (2002)
3. Goris, K., Saldien, J., Vanderborght, B., Lefeber, D.: How to achieve the huggable behavior of the social robot probo? a reflection on the actuators. Mechatronics 21(3), 490–500 (April 2011)
4. Gray, C.: The new social story book. Future Horizons Inc (2000)
5. Pradel, G., Dansart, P., Puret, A., Barthelemy, C.: Generating interactions in autistic spectrum disorders by means of a mobile robot. In: IECON 2010-36th Annual Conference on IEEE Industrial Electronics Society. pp. 1540–1545. IEEE (2010)
6. Robins, B., Dickerson, P., Stribling, P., Dautenhahn, K.: Robot-mediated joint attention in children with autism: A case study in robot-human interaction. Interaction Studies 5(2), 161–198 (2004)
7. Saldien, J., Goris, K., Vanderborght, B., Vanderfaeilli, J., Lefeber, D.: Expressing emotions with the huggable robot probo. International Journal of Social Robotics, Special Issue on Social Acceptance in HRI 2(4), 377–389 (2010)
8. Vanderborght, B., Simut, R., Saldien, J., Pop, C., Rusu, A.S., Pintea, S., Lefeber, D., David, D.O.: Using the social robot probo as social story telling agent for children with asd. Interaction Studies (under review)