An explorative study on robotics for supporting children with Autism Spectrum Disorder during clinical procedures

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ABSTRACT

This short report presents a small-scale explorative study about children with Autism Spectrum Disorder (ASD) interaction with robots during clinical interactions. This is part of an ongoing project, which aims at defining a robotic service for supporting children with developmental disabilities and increase the efficiency of routine procedures that may create distress, e.g. having blood taken or an orthopaedic plaster cast applied.

Five children with confirmed diagnoses of ASD interacted with two social robots: the small humanoid NAO and the pet-like MiRo. The encounters mixed play activities with a simulated clinical procedure. We included parents/carers in the interaction to ensure the child was comfortable and at ease. The results of video analysis and parents' feedback confirm possible benefits of the physical presence of robots to reduce children's anxiety and increase compliance with instructions. Parents/carers convincingly support the introduction of robots in hospital procedures to their help children.

KEYWORDS

Social robots; Pediatric care; human-robot interaction; Autism.

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1 Introduction

Children with ASD may experience specific challenges during clinical appointments, such as increased anxiety in unfamiliar settings which may lead to difficulties in interactions, thus, clinicians may not be able to engage and interact effectively with these children. These difficulties can act as a barrier to receiving effective health care [13]. Children with ASD are likely to need modified approaches to communicate and interact with them effectively to help them understand what is going to happen to them and to reduce their anxiety [4].

In this regard, social robots may represent a solution to support healthcare providers and children, indeed robots are acceptable social partners for children with ASD and have a physical presence and can simulate a social interaction, including non-verbal cues (eye gaze, gestures, posture) [12]. Indeed, current social robotics projects are increasingly showing numerous benefits in the treatment of children with ASD [14], e.g. they can improve training [5] and support automating the assessment during the therapy [10]. The use of robots in clinical practice should aim at improving the quality of the care and, at the same time, to reduce the therapists' workload by enabling effective and efficient interactions and clinical procedures [6,7].

Though, most of the studies presented in the literature focus on the training and improvement of behaviour of children with ASD [8], but only a few explore how social robots can support them in other clinical procedures. However, this application seems promising as there are some examples of the robot was used in paediatric hospitals to help typically developed children by providing education, diversion, and companionship [1,9]. Notably, two studies have shown that a humanoid robot can engage and effectively divert children's attention away from their worry of fear and pain of the vaccination [2,11].

2 Material and Methods

Participants were 5 children under 5 years old, with ASD and speech, language and communication needs. Children were recruited via the Sheffield Small Talk clinic, which is a parent/carer support group for pre-school children with developmental disorders. The parents/carers received an information sheet detailing the study and the potential involvement of their children and themselves. All the parents give written informed consent for their children to participate and the children gave their assent. The study received ethical approval from Sheffield Hallam University.

Two social robots were employed: the Softbank Robotics NAO which speaks, dances and gives instructions to the child; the Consequential Robotics MiRo which behaves like a pet dog, randomly moving around, making noises and barking. NAO offered multimodal interaction via tactile sensors and four

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directional microphones, voice recognition and text-to-speech. MiRo provided only a basic pet-like interaction. MiRO was included as an alternative to NAO, because of the young age and the communication difficulties of the participants. As usual in the clinical interventions we plan to support, parents could stay and participate in the interaction. In fact, they represented a secure base to help the children to be accustomed to the robots [3].

The semi-structured encounters started with an introduction to help the children to familiarize with the robots. In the introduction, NAO presented itself and engaged the children by playing music and storytelling, then asking to imitate its dancing movements. The former was to engage and verify the child attention, while the latter was to test child compliance and imitation skills. After this introductory interaction, NAO introduced a pretend clinical procedure in which the nurse had to apply a plaster on the child's arm. Having physical contact with a stranger can be a stressful experience for children with ASD. To favour the understanding of the procedure, NAO asked first the children to apply a plaster on its arm so that they can physically experience and understand the procedure (Figure 1). Finally, NAO instructed the children to follow MiRo to the sink to wash their hands. Once the pretend procedure was completed successfully, the children were free to play with the robots, while parents completed the survey. All encounters were video recorded.

Figure 1. Left: A child is applying a plaster on the NAO arm. Right: A child went to the sink for washing his hands following NAO instruction. NAO is the humanoid robot in both pictures. MiRo is at the bottom of the left picture.

We used two bespoke measures to analyse the encounters: (i) an interaction behaviour analysis of the videos; (ii) a short survey completed by the child's parent after the session.

3 Results and Discussion

Four of the five children enjoyed interacting with both robots for 22 to 42 minutes. One child was withdrawn from the study after a few minutes; this was because he did not want to be in the room with the Nao. In the survey, his parent reported that "*he was put off by the empty room other than the robots*". Another one of the children was initially hesitant and stayed at distance. The child relaxed after a few minutes when the NAO robot invited to touch its arm. Then, he was happy, and it is the one who spent the most time freely playing with the robots after the simulated procedure.

In the video analysis, very good compliance with NAO's instructions is recorded by three children, i.e. they promptly executed 90%, 83% and 73% of the robot's instructions, while one carried out only a few instructions (17%). However, the four children completed the simulated procedure and were happy to stay longer to play with the robots. We noted that most of the children focused their attention to NAO with two children almost completely neglecting MiRo. This can be explained by the more advanced interaction skills of NAO, which was engaging the child with spoken instructions during the procedure. Typically, children considered MiRo only during the final unstructured play.

Table 1 reports the results of the survey completed by the 5 parents. Answers mirrored the behaviours we observed in the video analysis. Some parents added interesting comments to open questions included: the robot "*put the child at ease*"; "*Encourage imitation and interaction*"; some noted positive behaviours like "*kissed the robot twice*" or distinctive physical contact that the child reserves to close family "*if he is really happy in your company*". It is interesting to note that the parent of the child who was withdrawn agreed that "robot(s) could be used to help children feel more comfortable" and specified "*some will like it*".

Table 1. Results of the survey.

Answers are aggregated associating a numerical value: yes (1), no (0). The maximum aggregated value is 5. Two exceptions are the ratings that are up to 10.

Do you think your child was comfortable being with the robot?	4
Please rate your child's experience with the robot(s) 10 is the most comfortable and 1 is the least comfortable ever	7.2
Do you think your child was distressed being with the robot(s)?	0
Please rate your child's experience with the robot(s): 1 is the most distressed ever and 10 is the least distressed ever	7.4
Did your child interact with the robot(s)?	5
How did your child interact with the robot(s)?	
Looking at the robot(s)	5
Getting close to the robot(s)	4
Touching the robot(s)	4
Listening to the robot(s)	4
Copying/imitating the robot(s)	3
Carrying out the instructions from the robot(s)	3
Talking to the robot(s)	1
Joining in with the robot(s)	3
Do you think robot(s) could be used in ways to support your child	4
In a setting like a hospital, do you think robot(s) could help children feel more comfortable when having a procedure such as having blood taken, an x-ray taken, a plaster cast put on or other procedure?	5
What do you see the role of a robot(s) with a child?	
Distracting the child from the procedure	3
Reducing feelings of worry or anxiety	4
Helping a child to feel more comfortable in an unfamiliar setting	4
Helping the child to come away from a parent/carer	3
Helping the child to tolerate something they don't usually like	3

4 Conclusion

Robots can be an instrument for the enhancement of the care already in place, rather than a replacement of the human caregiver. In this study, we have explored the introduction of robots as a claiming and supportive tool, which could make for less stressful and more successful healthcare encounters for children with ASD. Preliminary results and parent's feedback presented here confirm the potential application of social robots to support children with ASD in clinical procedures other than training. Indeed, we have planned to test whether the use of robots may reduce resistance to procedures and refusal to engage in order to cut down on wasted appointments, particularly when children access non-specialist services.

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