Robots and Autism Disorder: Promoting competence generalization

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Abstract. One nuclear behavior modification in people with autism is a qualitative change in social interactions, resulting in the pursuit of social isolation, instrumental relationships, absence of an awareness of emotions and feelings, and difficulty in imitating actions or situations with a more representative content. Up to the moment, the work developed by this team aimed to investigate how robots can contribute to encourage active participation of the autistic children and to promote the social interaction between the child and ~~the~~ others, exploring the concept of generalization of acquired skills. However, very low-level robotic platforms, such as Lego MindStorm were applied. In future work, a humanoid robot with more abilities, including a wider range of sensors and with the possibility of using facial expressions and basic communication, is intended to be used.

Keywords: Social Robotics, Autism Therapy, Special Education

1 Introduction

Autistic Spectrum Disorders (ASD) typically manifests itself during the first three years of life and it can be defined as a global development disorder [1].

On the basis of diagnosis of ASD, which depends on compiling a personal history [2], it is considered three nuclear behavior modifications, as follows: a) Qualitative changes in social interactions; (b) Qualitative changes in verbal and non-verbal communication abilities; c) A reduced, repetitive and stereotypical repertoire of activities and interests [3].

Thorough research [4-8] focuses on the application of robots into the classroom for children with autism, with the main goal of supporting professionals/ therapists and families in the development of the children's cognitive capabilities, social interaction and communication skills. Robots seem to work as a key tool calling on the attention of autistic children, and therefore promoting their cognitive and social development [9].

The work presented in this paper is part of a larger collaborative project [10, 11] between the University of Minho, APPACDM (an association for mentally disabled people) of Braga and the Special Education Unit of Gualtar Primary School in Braga. The project's main aim is to develop a robotic tool able to improve the social life of children/adolescents with autism, in particular to promoting their social interaction and communication.

2 Related Work

More recently, the use of robotic toys have been explored to facilitate the therapeutic process of children with ASD, with the robot acting as a mediator between the child and the therapist.

Project AURORA (AUtonomous RObotic platform as a Remedial tool for children with Autism) [4] looked into how autonomous mobile robots could support children to become engaged in different interactions. The authors concluded that 1) the robot is safe for children to use/play, 2) the large majority of children are not afraid of the robot, 3) the children are very motivated to interact with the robot, 4) the children are usually more interested in the robot playing in 'interactive' mode compared to the robot showing non-interactive behavior and 5) the children have no problem coping with the robot behaving reactively but are not completely predictable.

Robota is a doll-shaped robot which uses a motion tracking system to copy upwards movements of the left and right arm of the user when the user faces the camera and reacts to touch. To measure the latter, Robota engages the children in simple imitation games, using the legs, arms and head [5].

KASPAR is an autonomous robot in call-and-response games, where its goal is to imitate the human partner's [6]. The researchers show that the use of KASPAR, not only can demonstrate some important interactional competencies, but also show a level of direct engagement and children appear to generalize this behavior at least to the other people in the room.

Keepon is a simple robot with minimal expressiveness designed to conduct nonverbal interactions with children with autism and to help to elaborate psychological models of the social intelligence development [7].

IROMEC project (Interactive Robotic Social Mediators as Companions) takes into account play needs of children focusing its educational and therapeutic goals on reducing children's limitations by taking advantage of their strengths. The researchers conclude that IROMEC as a programmable system (defined as play scenarios) can provide several stimuli that can promote the interaction with the child in different ways [8].

3 Work Developed

The overall research project is focused on answering the question: 'Can the robot be assumed as promoting stimulus in establishing social interactions with children with ASD?' In this way, a mobile modular robotic platform was used as a means (a mediator/promoter) to: a) encourage active participation of the autistic child, and b) promote the social interaction between the child and the others, exploring the concept of generalization of acquired skills.

3.1 Participants and Sessions

An 11 year old autistic child was chosen as the target group for the experiments. He is not able to speak, but he is capable of producing vocalizations. He manifests difficulties in establishing eye contact, in the interaction with pairs and adults and, above all, difficulties in directing and keeping the attention. At the behavioral level, he reacts strongly to changes in daily routine by crying or even showing aggressive manners. He has not made acquisitions of academic skills: reading, writing and arithmetic calculation.

The activity set-up was constituted by: the researcher and the child, the robot, a guide-path and a ball. The bidirectional task assigned to the experiments constituted of throwing a ball by the child in the direction of the robot, upon request from the adult, and vice-versa, the robot sent the ball to the child, upon child verbal request.

3.2 Research Test Program

The test program was divided into five phases: Familiarization, Pre-test, Practice, Re-Test and Generalization during two months.

The main goal of the first phase, Familiarization, was to get acquainted ~~to~~ with the child and the integration of the researcher in his school environment. The Pre-test phase was the first test with the child, robot and researcher in the classroom. This test is considered the reference to be compared to later test stages, where some variables (game partner or experiment environment) were then changed. After demonstrating how the experience ran, researcher test model, the child was requested to "ask the robot for the ball". The third phase, Practice, the task was introduced in the child daily work. Whenever the child correctly asked for the ball, the robot returned it. The objective was to test if the child had really acquired the competence. The Re-Test phase was completed in a different day. This phase had the same conditions of the Practice phase with the objective to evaluate the consistency of learning. Finally, the main goal of the Generalization phase was to perform changes of context (classroom and playground) and models (with known and unknown game partners) allowing to verify if the robot worked as a promoter to improve child social interactions.

After the video analysis of the sessions, the results showed that the child was perfectly able to autonomously answer the request, in both environments. In the Playground, the number of stereotypies registered compared to the Pre-Test was not significant and the time of interaction was higher than 75%. The last scenario included an unknown game partner in the classroom. Is it important to underline that this session was performed without the robot, exactly to see if the child could generalize the game objective with a human. Thus, he almost did not presented stereotypes in all-time session and the interaction time reached almost 100%.

4 Conclusions and Future Work

In this paper, recent results of several experiments performed with an eleven year old child with autism were described and reported. The goal was to improve his social competences, especially to promote his social interaction and communication by using a robotic tool. The child managed to perform the task in several constraints, despite the weak results in the Pre-Test. Future work includes using a humanoid robot with more abilities, a wider range of sensors and with the possibility of using facial expressions and basic communication.

Acknowledgments. The authors are grateful to teachers, therapists, students of the primary school EB1/JI of Gualtar, Braga and their parents for their participation in the project. The authors are also grateful to the Portuguese Foundation (FCT) for funding through the R&D project RIPD/ADA/109407/2009 and SFRH/BD/71600/2010.

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