ASD-ROBOT AS AN EDUCATIONAL TOOL FOR AUTISM SPECTRUM DISORDER LEARNING ACTIONS

ASD-ROBOT COME STRUMENTO DIDATTICO PER INTERVENTI EDUCATIVI PER I DISTURBI DELLO SPETTRO AUTISTICO

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Abstract

The paper presents a research project, named ASD-Robot, which aims to promote the development of social skills in children with Autism Spectrum Disorder. The robot was designed and built specifically to be integrated into the usual psycho-educational interventions for children with autism. This robot acts as a mediator in relationships between peers and promote social skills. Specifically, the aim of the project is to create an open-source robot that is programmable and customizable by anyone to adapt it to the particular needs of children.

Il contributo presenta un progetto di ricerca, denominato ASD-Robot, che mira a promuovere lo sviluppo delle competenze sociali in bambini con Disturbo dello Spettro Autistico. Il robot è stato progettato e costruito appositamente per essere integrato negli abituali interventi psico-educativi per i bambini con autismo. Questo robot agisce come mediatore nei rapporti tra pari e promuovere le abilità sociali. Nello specifico, lo scopo del progetto è di realizzare un robot open-source che sia programmabile e personalizzabile da chiunque per adattarlo a specifici bisogni dei bambini.

Keywords

Autism spectrum disorder; inclusion; robotics; social skills
Disturbo dello Spettro Autistico; inclusione; robotica; abilità sociali.

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Social robots to support children with autism

Recent research (Ferrari et al., 2009; Conti et al., 2015) has shown how the use of social robots in the scope of disability can promote the development of skills in deficit areas and the implementation of new social behaviors, particularly in children with Autism Spectrum Disorder (Ibidem). Other scientific evidence has shown that it is easier for the child with autism to interact first with the robotic mediator and then with the human being (Dust et al., 2013). According to Baron-Cohen's (2009) empathizing-systemizing theory (ES), children with autism prefer to interact with highly formal systems, whose behavior can be predicted and which have clear rules of engagement. In fact, robots can be programmed to adapt to the different needs of children, creating predictable relational situations so as to seem less threatening and decrease their level of anxiety. Positive aspects also emerged from the child-robot interaction (in the specific case of a child with autism) as regards social acceptability (Dunst et al., 2013), motor communication by imitation (Duquette, Michaud & Mercier, 2008), and maintenance of shared attention (Robins et al., 2005).

To understand the usefulness of the robot for children with autism, in particular to promote the development of social skills, DSM-5 (Diagnostic and Statistical Manual of Mental Disorders) is necessary to better consider the difficulties related with autism and to redefine everything in terms of impairment and to better understand the following categories of deficit:

- the *deficit in the area of social communication* (verbal language, non-verbal communication and ability to initiate social interaction)
- the *deficit of imagination* (restricted repertoire of stereotyped activities and behaviors)

In children with autism, these difficulties can interfere with learning and reflect anomalies in attention to social stimuli and in the ability to interpret the behavior and emotions of others. Hobson (1993a; 1993b), in the theory of the primary deficit in interpersonal relationships, highlights how children with autism are unable to understand the expressions of emotions, especially complex ones (such as pride and embarrassment). In fact, it is difficult for children with autism to interpret the behavior and emotional state of others as this ability is acquired through social relationships.

Consequently, the need emerges to act in this direction and to analyse how a social robot, and specifically ASD-Robot, can act in a concrete way on the recognition of the mental states of others and perspectives different from one's own.

ASD-Robot: Design and development

The previous paragraph indicated the main difficulties that children with autism have in social interaction, in interpreting the behavior and emotions of others. To act practically on these issues, we can consider the use of a social robot programmed to appear: modular, configurable, sensory level adjustable, social and agentive (Pennazio, 2019). In this way it is possible to work gradually on particular aspects of the robot, such as gestures, avoiding the child from sensory overload. Therefore, by introducing the robot in a school context, the teacher will be able to design activities for the child based on the characteristics of the robot, providing for a gradual approach and gradually extending the activity to their peers as well.

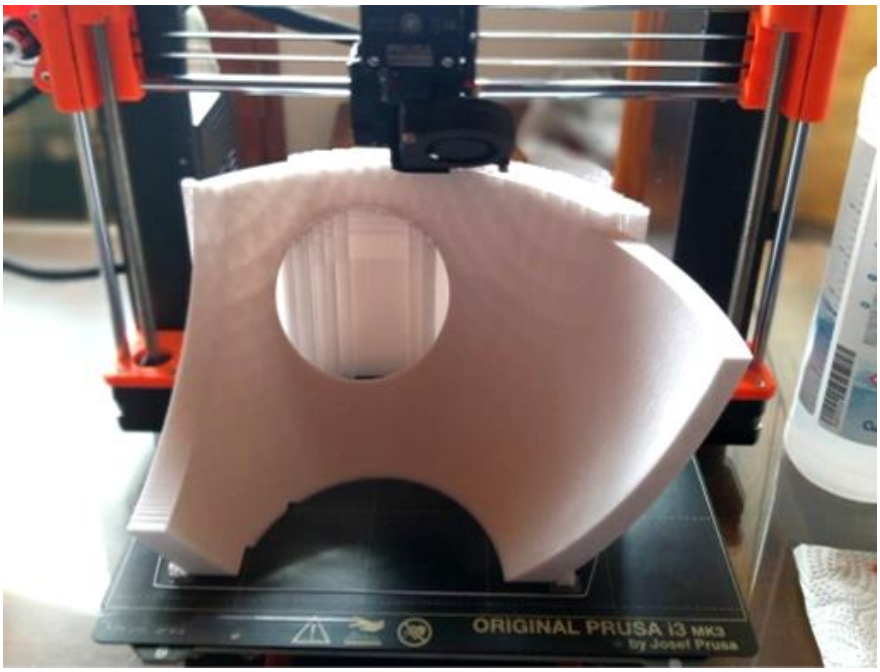

Figure 2: Realization of the robot through the *Prusa MK3s* 3D printer

In fact, the ASD-Robot project aims to create an open source robot to promote the development of social skills in children with autism (Campitiello, Todino & Di Tore, 2021). The robot can be considered as a learning companion in activity sessions that involve free interaction with the automaton. ASD-Robot was developed in the Lab-H of the DISUFF Department of the University of Salerno. For the design of the robot, Rhinoceros CAD modeling software and the Prusa MK3s 3D printer were used to physically make it.

Figure 3: Assembly of robot parts and electronic connections

The use of the 3D printer has made it possible to reduce production costs and make the project customizable according to the different needs of children. ASD-Robot is equipped with a *LattePanda* board connected to the display and the camera (to allow you to express different emotions) and an *Arduino Uno* microcontroller to manage the movement of the servomotors of the neck and arms in order to give greater expressiveness to the robot. The 3D model of the robot is available on the Lab-H website (www.labh.it/asd-robot) in order to be accessible to anyone interested in carrying out the project.

Figure 4: Some components of ASD-Robot

How to promote the development of the affective-emotional area in children with autism

In children with Autism Spectrum Disorder the development of affective-emotional relationships is different than in peers with typical development, as the ability to understand their own emotions and those of others is deficient. In fact, children with autism show difficulties in correctly interpreting the signals of the body, tone of voice and facial expression (Cottini, Vivanti e Bonci, 2017), consequently they are unable to recognize emotions, positive and negative. , in response to social relationships. To act concretely and encourage the development of these skills, it is possible to train the child to recognize their own emotions and those of others through interaction with the robot. In the specific case, with the support of ASD-Robot, activities can be proposed to the child to be carried out gradually: in the first phase it is possible to suggest the child to carefully observe the characteristics of the robot's face (through the schematic drawings) and, subsequently, try to recognize emotions through facial expressions in photographs and physical attitudes. The schematic drawings, which

show the different emotions on the robot's face, were created through the use of the PowerPoint software, in reference to the Theory of Mind (TOM) developed by Howlin (1999).

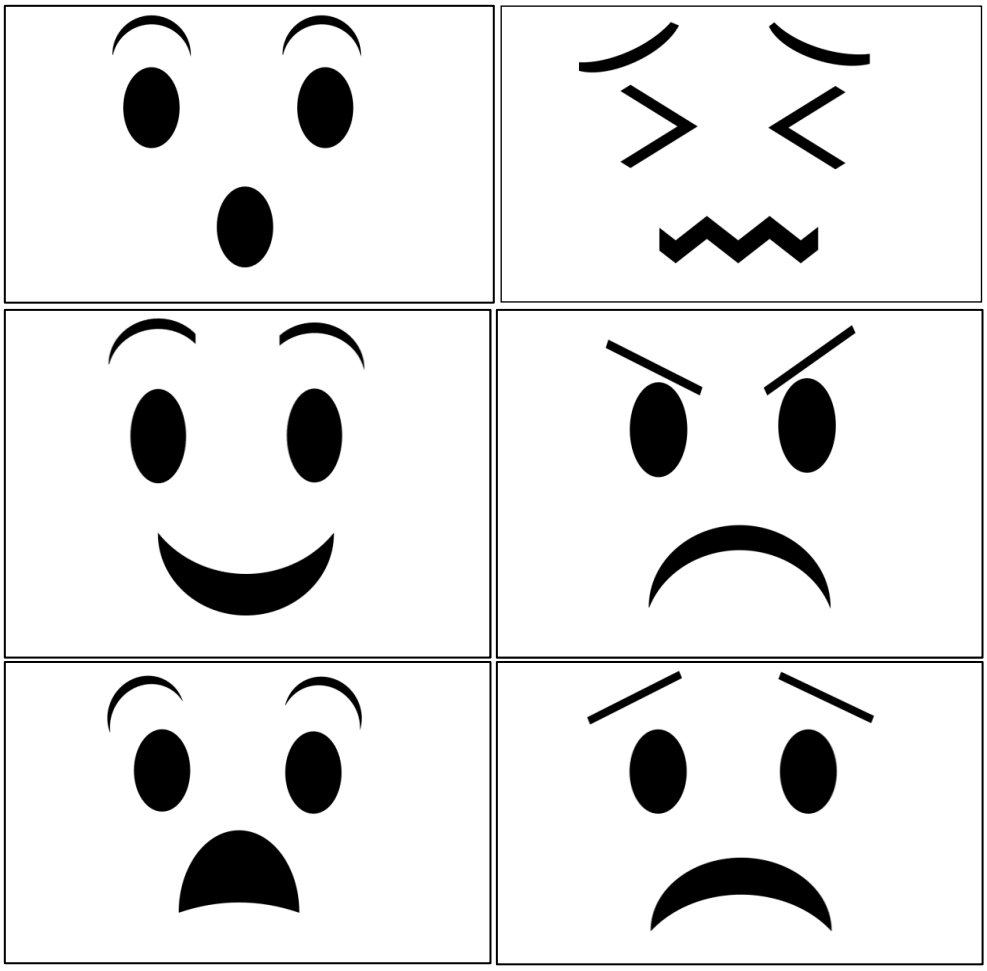

Figure 5: Primary emotions in schematic drawings

Using the Howlin method program, which aims to support the development of the mentalization process in children with Autism Spectrum Disorder, the basic idea is to digitize part of the program divided into three main parts: emotions, belief system and false beliefs, and the play of fiction and symbolism. The first part of the program is based on the emotions in which the educators propose exercises to the child that ask to pair photos of actors showing the same expression, and then move on to the schematic drawings to facilitate the identification of the physiognomic conformations that characterize a given expression. In the next level, relating to emotions caused by desires, the child is asked to identify the feelings of those who see their wish come true or not. In the last level, that is the emotions caused by opinions, the child is presented with a sequence of figures in which: the real situation is represented in the first image; the second shows what the character wants; while in the third the conclusion of the story is reported.

Therefore, in the specific case, during individual activities with the child, the face of ASD-Robot will be able to express the different emotions through schematic drawings and, to exercise the recognition of emotions also through attitudes, the tablet will be able to show images of emotions. through the posture of the body. As for the next step, it is possible to use the robot in small groups of peers, offering a simulation game of the

emotions that the robot displays on the face, to give the child the opportunity to experience a state of mind with others. In this way, the child interacts first with the robotic mediator, then with the teacher and the group of peers. Furthermore, through the planning of such activities with the robot, it is also possible to intervene in the social area, that is the ability to respond adequately to social stimuli and to relate positively with others (Cottini, Vivanti & Bonci, 2017). In fact, children with autism are unable to implicitly learn social rules, so it is necessary to create situations that improve the acquisition of these skills. Furthermore, it should not be assumed that the child is able to learn every exercise that is proposed to him or that he is naturally able to generalize a behavior that is acquired in a certain context. For this reason, care must be taken to propose activities that motivate the child and help create a stimulating context.

ASD-Robot "at school"

In the school context, ASD-Robot can be considered as a tool to stimulate motivation through play and promote the development of specific skills in children, especially for children with autism. Through play, the child explores the environment, learns and develops social relationships (Piaget, 1926; Bateson, 1956), but often children with autism do not have the opportunity to fully experience this experience due to cognitive and sensory deficits, but also by the absence of accessible game material suitable for every specific need. Therefore, the use of the robot in playful activities can stimulate the child with autism and classmates to learn and socialize (Pennazio, 2015). Although the child with autism does not show interest in interacting with others, it is possible to plan activities with the robot that gradually involve the participation of the peer group. In this way, it is also possible to teach the child to use the robot in a functional way, initially showing him how to relate and suggesting to imitate the actions performed, waiting for him to perform them independently. Initially, this activity can be shared with only one peer and then be extended to the group in order to respect the shifts and learn to collaborate together to achieve a common goal.

Therefore, ASD-Robot can assume the role of functional game, acting as a peer or a toy, and facilitating the relationship between the child, the teacher and peers within sessions that provide for the preparation of playful activities to stimulate interaction. social. The robot is intended as a social mediator who initially places himself between the teacher and the child to bridge the distance between the predictable world and the complex world of human interaction (Costa et al., 2014). In addition, ASD-Robot can be used during psycho-educational interventions, supporting the child during therapy sessions and offering the educator / therapist the opportunity to observe how the child interacts with the robot and responds to the stimuli offered by the therapist.

Conclusion

Nowadays, there are social robots created specifically to interact with children with Autism Spectrum Disorder, the aim of the following work is to create an open-source robot, downloadable for free through the Lab-H website, specifically designed to be used in schools of all levels with children with autism. ASD-Robot, in addition to being available and accessible to all through the site, is customizable and programmable by anyone who intends to build it and adapt it to the specific needs of children with disabilities. Therefore, the approach used is to hypothesize that social robots can act as assistive technologies, promoting the development of social skills in children with autism through daily activities. The robot can also support methodologies already tested by educators (such as the ABA method) and be considered as a therapeutic tool, which can be customized according to the child's problems, aiming to strengthen the therapy.

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