

“Robotics and cbt and entertainment in the enhancement of children with asd, mental disorders, dysfunctional emotions and irrational beliefs”

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Abstract. Children and adolescents with autism spectrum disorder (ASD) frequently present symptoms of various mental disorders along with the features that define ASD. Problems with anxiety, depression, emotion regulation, cognitive problems, such as deficits in theory of mind, and associated behavioral problems, occur in children with autism of all ages [5]. In recent years, the application of robots in therapeutic interventions for children with neurodevelopment disorders and more specifically in children with ASD, has aroused the interest of the robotic community and experts in the field of autism [3]. Socially Assistive Robots are promising in their potential to promote and support mental health in children with ASD. There is a growing number of studies investigating the feasibility and effectiveness of robot interventions in supporting children's mental wellbeing, such as helping in anxiety, depression and socio-emotional problems [3, 4]. Several authors have also suggested Cognitive and Behavior Therapy (CBT) as a very useful intervention therapy, which can apply in combination with a social assistive robot [5, 6, 8]. CBT has specific strategies that can be very supportive and particularly useful for individual's problems. Many applications of this combination have shown substantial improvements in stress management, contextualized emotion recognition and theory of mind. With a coordinated effort, robot, cbt techniques and collaboration with mental health consultants, children with ASD can improve their social, emotional and behavioral competence [5].

1.Introduction

Children diagnosed with autism face difficulties in social interaction, communication and imagination as well as difficulties in understanding other people's feelings and intentions, in social relationships, in understanding expressions and movements but also reduced visual contact and involvement in game. In addition, they show symptoms of mental disorders such as anxiety, depression, phobias and obsessions [5].

Various researches focus on intervention programs in order to reduce these symptoms, manage them and cultivate new skills, social and emotional. The methods used in therapeutic interventions involve efforts to involve children with autism in activities to develop basic social behaviors, which is often difficult to achieve due to the unpredictable nature of these children [6].

The most effective therapeutic approach according to several researchers is Cognitive and Behavioral Therapy. This psychotherapy seeks to manage the symptoms by using various techniques such as relaxation techniques, focus on the imagination, use of metaphors, cognitive reconstruction, role-playing games, etc. It is practiced by psychologists, psychotherapists, psychiatrists and other mental health professionals [5, 6, 8].

Many studies have shown that children with autism show more interest in interacting with robots as they become fascinated with them and do not cause confusion and intimidation as in interacting with a therapist or pedagogue [3, 4].

The robots used in therapeutic interventions for children with autism are called Socially Assistive Robots (SARs) and are a large field of study of the field of Human-Robot Interaction (HRI) in the development of interaction of different categories of people [3]. The role of SARs is to provide assistance through social interaction to people or children with reduced or no social and cognitive skills. The most famous social robots which are used in the identified studies are Nao, Keepon and

HUMANE robots (Saadatzi, Pennington, Welch, & Graham, 2018. Sartorato, Przybylowski, & Sarko, 2017).

2. Methodology

The methodology of this review was based on the guide by Ahn & Kang (2018) with the title "Introduction to systematic review and meta-analysis". According to this methodology, a systematic review should be based on five essential steps. Five methodological steps to conduct the review: 1) Formulation of research questions, 2) Inclusion and exclusion criteria, 3) Rigorous literature search, 4) Data extraction and analysis, 5) Presentation of results.

2.1. Step 1: research questions

The researchers formulated the research questions which were:

- a) what social robots can offer to children with ASD?
- b) how effective can the combination of social robots and cognitive behavioral therapy be to children with ASD?
- c) what strategies this combination uses in order to help a children with ASD and anxiety?

2.2. Step 2: inclusion and exclusion criteria

Inclusion Criteria

- The publication is a peer-reviewed study, conference proceeding or paper
- The publication is in English
- The intervention reported focuses on children aged 3–14 years with ASD
- The study focuses on the robotic intervention
- The study presents the combination of robotics and CBT

Exclusion Criteria

- Grey literature (reviews, meta-analyses, dissertations, book chapters and posters) was excluded
- Sample including only adolescents and/or adults with ASD
- The publication includes participants with Asperger Syndrome, Rett Syndrome, Childhood Disintegrative Disorder, Pervasive Developmental Disorder not Otherwise Specified,
- The publication does not report on ASD.

2.3. Step 3: literature search

A literature search was conducted in the databases of Scopus, PubMed, PsycINFO, Web of Science, EBSCO, MEDLINE, and Google Scholar, using a combination of the keywords "Mental disorders" and "Autism or Autism Spectrum Disorder or ASD", and terms referring to "Child" (e.g., children, preschool, elementary school, middle school, boys and girls), "Robotics" and "CBT". The combination of the above keywords was applied to each database from 2001 up until August 2021.

2.4. Steps 4 & 5: data extraction and interpretation of results

Data extraction and analysis: the analysis of results was based on the evidence and data given by the chosen articles. Interpretation of results: Interpretation was based on the research questions. Each question was answered separately. The specific bibliographic review was carried out by the psychologist and PhD candidate Areti-Eirini Filiou, with the support and supervision of Professor Syriopoulou-Delli Christina. The topic was chosen by the psychologist and after consultation and guidance by the teacher, this article was created. After selecting the articles from the databases, they were studied and processed. Then the basic data from the articles for the implementation of the work were gathered. The writing of the paper was based on the publication manual of the American Psychological Association (APA).

3. Results

Table 1. Presentation of research articles that were analyzed and general information

<i>n.</i>	<i>Authors</i>	<i>Number of participants</i>	<i>Year</i>	<i>Participants age</i>	<i>Name of the robot</i>
1.	Costescu, et al.	27	2017	3-5 years	Keepon
2.	Marino, et al.	14	2020	4-8 years	NAO
3.	Saadatzi, et al.	3	2018	6-8 years	NAO
4.	Sartorato, et al.	11	2017	4-7 years	NAO
5.	Spain, et al.	10	2015	4-8 years	NAO
6.	Sprung, et al.	19	2015	4-7 years	NAO
7.	Yun, et al.	15	2017	6-8 years	HUMANE robots
8.	Wood, et al.	14	2020	4-6 years	NAO

The research papers that were chosen for analysis for this review were regarding the use of social robots combined with CBT for children with ASD and the participants' ages were between 3 and 8 years. As it is summarized in Table 1, the number of the participants were between 3 and 19 children with ASD. The year of publication of these articles was between 2015-2020.

Each article used different kind of robots for the intervention. Specifically, [2, 3, 4, 5, 6, 8], use the robot NAO. The humanoid robot NAO is a commercially available (*SoftBank Robotics*) child-sized, plastic-bodied humanoid robot (58 cm tall, 4.3 kg) equipped with 25 degrees of free- dom (DOF), tactile and audio sensors, and a wide variety of actuators (e.g., direct current (DC) servo motors and LED displays). The intervention setting included the humanoid robot, NAO, which acted as co-therapist, providing emotional and communication prompts and reinforcements.

The robot Keepon used by [1]. Keepon is a small robot with a silicone- rubber body, resembling a yellow snowman. The robot sits on a black cylinder containing four motors and two circuit boards, via which its movements can be manipulated with four degrees of freedom. Keepon has been widely used in human-robot interaction studies with social behaviours (e.g. eye contact, joint attention, touching, engagement, and imitation).

[7], use two HUMANE robots. HUMANE has been used in autism and eldercare. It is approximately 25 cm tall and weighs 3.2 kg. Its human attributes include baby face-like appearance, voice vocalization, face recognition, face registration and face tracking, facial expressions, gestures, body motion sensors, dance movements, touch sensors, emotion recognition, and speech acoustics recognition.

3.1. Research question 1: Socially Assistive Robots and ASD

Initially, Socially Assistive Robots were used to diagnose and treat children with autism [3, 4]. More specifically, when robots are used to diagnose autism, they observe children in ways and methods that humans cannot do. Monitoring children's eyes promises early diagnosis of autism. In terms of therapeutic interventions and as mentioned earlier, children feel more comfortable interacting with robots as opposed to humans [3].

SARs, as we have seen, are used in a wide range of applications, including autism. Their use as a tool for diagnosing autism and as a means in therapeutic interventions for the socialization of children is also being studied [3, 4]. The use of SARs in the treatment of children with autism, lies in the formulation that these children show particular fondness for mechanical objects and computers. Because of this observation, the use of SARs may facilitate the development of social stimuli in children [3, 4].

Observing the specific intervention programs with the use of robots, it becomes obvious the continuous investment in the interactive technologies which include or not fully autonomous robots. In all therapeutic approaches, the robot does not replace the therapist or special educator who interacts with the child, but instead supervises and controls his activity and uses it depending on the intervention [3, 4]. When using robots in interventions, the variety of difficulties faced by children

with autism spectrum disorders is taken into account, so that they are precisely adapted to the needs and requirements of each child [5, 6, 8].

3.2. Research question 2: Robot-enhanced therapy

Research supports CBT as the best possible treatment approach for treating underlying symptoms and comorbidities in children with ASD [1]. There are studies showing that CBT can be effectively adapted to treat emotional problems in children with ASD and significantly reduce mood disorders in people with ASD [5, 6, 8]. Its use is most effective when combined with an SAR [1, 2, 7]. The use of a psychotherapy protocol by the therapist with the contribution of a robot is called Robot-enhanced therapy [2]. This treatment takes place in an individualized context of psychotherapy and is based on protocols followed by the specific psychotherapy. The robot can be considered as a technological tool that can help psychotherapists achieve their clinical roles and goals [1, 2, 7].

Social robots as mediators apply techniques mentioned in the CBT protocols, thus helping children with autism in socio-emotional comprehension, empathy, socialization, to regulate their negative emotions such as stress and anger and to learn to relax. International studies show that this type of treatment is very effective and helps children with autism a lot [1, 2, 7]. They themselves benefit from contact with the social robot, learn new skills and through relaxation and management techniques of thoughts, feelings and behaviors are able to control and manage symptoms of mental disorders that may occur. In addition, they appear to have higher emotional control and self-regulation, shorter and less intense outbursts of anger, and higher emotional comprehension [1, 2, 7].

3.3. Research question 3: A CBT robot for anxiety

Stress in children with autism is a very common phenomenon. Anxiety about social contacts, school, special phobias. The goal, then, is to relax and reduce physical symptoms through the CBT robot.

In the first phase, our goal is to introduce the robot to the child with ASD and to cultivate calm and confidence [2, 3, 5]. In this phase, the child is introduced to the robot, which takes the form of a spontaneous discovery, with the discreet presence of the teacher, who handles the robot, secretly / discreetly, so that the child is convinced of the robot's autonomy and give substance [3, 4]. The child interacts with the robot through conversation. The questions require first simple answers and then even descriptions. In case there is a lack of speech in the child, actions are followed to demonstrate answers using a tablet and with a tangible interaction with the robot.

Upon entering the session, the robot says "Hello" to the child. This greeting scenario has been developed to provide emotional interaction [3, 5]. The robot, at the same time as greeting the child, shakes his hand accordingly to show that he greets him.

The robot asks the child to tell him various information to get to know him, such as his name, his favorite color, his favorite toy, if he likes music, if he likes children's fairy tales, what he does not like and it bothers him , what he does in his free time, if he has friends, how he feels and other information about him in order to start the conversation and to show the child that he is interested in getting to know him. While asking questions, in order to show the robot to the child that he is interested in him and to create an atmosphere of trust and intimacy, the robot makes movements with his hands (swinging up and down) as a person does while talking. This is done so that the robot comes as close as possible to the child. The robot uses the movements of its hands and body, as research shows that it likes and wins children with autism to notice it and want to interact with it [5].

During the first discussion the robot uses supportive phrases such as well done, very nice, very good what you say to me, and joy etc. in order to cultivate a first level of self-confidence in the child. So the child with autism will slowly begin to feel good about the robot, begin to trust it and want to stay with it. In addition, the robot says things about itself such as my name, my favorite color is blue, etc., so that there is discussion on both sides and the child feels familiar as if talking to a his friend [6].

In this phase, depending on the preferences and capabilities of each child, games, songs and fairy tales are integrated, which help even more in the familiarization with the robot as an entity but also as a tool [6]. The first phase will be repeated until the child shows the required familiarity, comfort in interaction, as well as confidence in the robot, so that he feels safe. It is completed in case the child shows discomfort and refuses to cooperate.

The goal is to introduce the child to the robot, to cultivate an initial relationship of trust and through conversation, music and fairy tales the child feels familiar and calm with the robot.

In this phase the child receives relaxation training from the robot, which includes 3 steps. These steps were based on the principles and protocol for stress and relaxation techniques offered by Cognitive and Behavioral Psychotherapy ([6, 7, 8]. This approach shows that it helps children with autism to relax, feel their body and be left to the instructions of the announcer, in this case the robot.

Relaxation training is commonly used to reduce stress and normal arousal. This technique includes diaphragmatic breathing, which can be taught to the patient, muscle tension release activities, and image-based strategies [6]. Relaxation can help children and adolescents realize the increased tension, which serves as a sign of relaxation, and they are taught specific relaxation exercises that they can use to reduce tension [6].

The first step is to play with the 10 candles, the second is diaphragmatic breathing and the third is progressive muscle relaxation. During relaxation the robot will play relaxing music while speaking in a slow and quiet voice. In addition, the robot will support the child with phrases such as you are doing

very well, well done, continue like this, in order for the child to feel confident and to continue the process of relaxation.

10 candles

Wexler (1991) created a Ten Candles exercise. The robot tells the child to imagine 10 lighted candles in a row and then extinguish each candle in an attempt to exhale. The robot applies the exercise itself by extinguishing the supposed candle, so that we can achieve the imitation of the exercise by the child. This intervention combines images and controlled breathing. This can also act as a kind of game between the robot and the child, which aims to start the session and introduce the child to the relaxation that will follow [6].

Diaphragmatic Breathing

In this step the child learns a breathing technique based on his diaphragm. This focused breathing helps a lot in relaxing and eliminating negative emotions. Inhalation alerts our body, while exhalation has a calming effect [5,6]. By focusing on breathing and diaphragm movement, the nervous system can be affected and heart rate can be slowed.

The robot, therefore, gives verbal instructions to the child on how to perform the breathing. E.g. - Put one hand on the chest and the other on the stomach. - Take air from your nose and let your stomach swell. - Gently and calmly, take the air out of your nose. The robot, while saying the instructions for diaphragmatic breathing, at the same time follows them, putting one hand on the chest and the other on the abdomen. This will make it easier for the child to imitate the robot and do diaphragmatic breathing. At the same time, relaxing music is heard and the robot's voice is in low and soft tones. In addition, the robot strengthens the child with verbal rewards, well done, you are doing very well, he continued, in order to encourage the child to continue the process. 3 and 4 breaths can be taken.

Progressive muscle relaxation

In this step the robot instructs the child again with a slow tone of voice and with music in the background, how to gradually relax the muscles of his body. It starts from the bottom up. First the toes, the whole foot, the waist, the back, the fingers, the whole hand, the neck and finally the head. The robot gives instructions to the child such as: - first you will relax the muscles in your toes. - You feel heavy. - Let them go. At the same time the robot tells the child to think of happy pictures to relax more easily [6]. Simultaneously with the relaxation instructions, the robot's eyes light up in a light blue color, which relaxes the child even more. In addition, the hands are shaken up and down slowly at the best possible relaxation.

4. Discussion

The results of recent research show that robot-assisted interventions can greatly help children with ASD in learning and improving various skills [1, 2, 7]. These skills focus on his social and emotional deficits, such as self-regulation, anxiety-related symptoms, anger, depression, emotion regulation, cognitive problems, such as deficits in theory of mind, and associated behavioral problems. Social robots apply CBT protocols, using a variety of cognitive and behavioral techniques, to help and support children with autism. The international literature shows that the application of these techniques by social robots is effective and helps these children [1, 2, 7].

Limitations of this research are the existence of many surveys in the US and England and no one in Greece. An additional limitation is the need for quantitative research, ie research that will be done in society, at school or in a family context with interviews with individuals and intervention. These techniques are applied to children with ASD elements, which are quite functional. To apply to non-verbal children, younger children or people with intellectual disabilities they need to be adapted. This adjustment can be made using a robot, or using music, dance and other media. Research needs to be developed to include the adaptation of robotics and CBT techniques to non-verbal children, younger children and children with intellectual disabilities.

The research can be used by people working in mental health structures, psychiatrists, social psychologists, social workers. In addition, it can be used by specialists working in the field of education such as, special educators, teachers. These people have the opportunity to use the research for personal information, for personal improvement, in their work as an aid but also for carrying out various intervention research.

A proposal for future research is to conduct quantitative research - intervention research, which will help to apply all this theoretical knowledge in a practical level and to present their effectiveness to children and adolescents with ASD.

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