Therapy and Education Techniques for Children with Autism

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ABSTRACT
Autism is one of the disorders that falls under the Autistic Spectrum Disorder (ASD). It is a disorder which can change the entire life of not just the individual with the disorder, but also people around them. This paper talks about the problems faced by autistic children. Current research in this field dealing with solutions and therapies which aid children with cognitive disabilities, especially autism, is also discussed.

Keywords

1. INTRODUCTION
There are varieties of cognitive/mental disabilities that are seen in children at a very young age. These are also termed as learning disorders/difficulties since they affect the development and learning ability of a child at an early age. Some of these disorders are: autism, attention deficit hyperactivity disorder (ADHD), Asperger’s Syndrome, etc. It becomes very important for the parent or caretaker to spot the disorder early on so that the child can be given treatment and special care to help them in the learning and development.

Children with autism face problems in social interaction and communication, have difficulties understanding gestures and non-verbal communication, and show restricted or repetitive activities and interests [1].

The three important factors that affect children with ADHD are inattention, hyperactivity, and impulsivity. Due to these developmental disorders, children with ADHD tend to be unpopular among peers [2].

Asperger’s Syndrome is very similar to autism, except that they have higher abilities and face lesser difficulties as compared to the children with autism.

Children with such learning disabilities need special attention for their education and development and thus it is important to find new solutions and research in this field. There is extensive research that is being carried out in the field of autism. Robots and Virtual Environments are used extensively for the therapy of autism, apart from a few other persuasive and ubiquitous technologies that are used to aid them in their living. In this paper, we will see the different research being carried out to help children overcome the problems that they face in autism.

2. BACKGROUND
Autism has a wide range in which it affects the children, generally called as Autistic Spectrum Disorder (ASD). Children with autism can have varying levels of disorder ranging from low-functioning autism to high-functioning autism. Low-functioning autism is the most severe form of autism and affects the most. As the name suggests it implies that the functioning of the child is very low. A child with low-functioning autism faces more problems and has fewer abilities as compared to a child with high-functioning autism. High-functioning autism on the other hand is less severe and thus allows the child more functionality compared to children with low-functioning autism.

Children with high functioning autism have a normal to high Intelligence Quotient (IQ) whereas children with low-functioning autism have a much lower IQ [3].

In general one could say that, it is easier to use therapy techniques to better the lives of those affected with high-functioning autism than those with low-functioning autism, though children with low-functioning autism need much more care and attention.

Autism is known to appear in children before the age of three [1]. It is believed that more than 1% of children are affected by Autism and the rate of prevalence of Autism is increasing by the day [4]. Autism doesn’t have a known cure, but there are therapies which could be given to the children with autism if diagnosed early. Also, autism is known to affect males more than females with an average ratio of 4:1 [16].

It is not easy to diagnose autism early, especially the high functioning autism. There are no accurate known quantitative methods for autism diagnosis, but it can be diagnosed by studying behavioral patterns of children [6]. Some of the
screening tools that are available for diagnosis of low functioning autism are Checklist of Autism in Toddlers (CHAT), the Screening Tool for Autism in Two-Year-Olds (STAT), and the Social Communication Questionnaire (SCQ) [6]. However, for detecting mild ASD like high functioning autism or Asperger Syndrome, the screening tools used are Autism Spectrum Screen Questionnaire (ASSQ) and Childhood Asperger Syndrome Test (CAST) [6].

Apart from using the screening tools, one can observe the child and find certain traits to diagnose autism. There are three main symptoms of autism, generally called as the ‘triad of impairments’:

- Social interaction
- Communication
- Repetitive behaviors and restricted interests

2.1 Social Interaction
This is one of the main symptoms of autism. Every child with autism faces difficulties in social interaction. Children with autism tend to shy out and don’t interact much with other individuals which leave them with poor social skills. This behavior tends to continue with time and eventually they withdraw from society and stop interacting unless some sort of therapy is conducted to help them. [7]

One of the most widely used therapy technique to facilitate social interactions in children with autism is using robots. It is found through some studies that autistic children behave normally in the presence of robots and show social behaviors which they otherwise don’t [8].

2.2 Communication
Another of symptoms shown by autistic children is poor communication. Though this is not as widely seen as the earlier symptom, it is prominent in low-functioning autism. Children with autism often lack language skills and find it difficult to communicate. They tend to take things literally and often have problems phrasing sentences and communicating. Also, they fail to catch the non-verbal cues like gestures and emotions. [7]

To help overcome these problems of communication, there are some virtual reality systems and other learning software which are used in educating the autistic child and improving their communication and social interaction.

2.3 Repetitive Behaviors and Restricted Interests
Another important symptom of autism is repetitive behaviors. Children with autism tend to pile up things in a straight line or row and also tend to repeat actions and sentences. This symptom can be easily ignored by parents or caretakers if not aware of it. [7]

There is no specific or special therapy to overcome this symptom; however this behavior plays an important role in therapies where children are made to imitate the robots to do actions and thus in effect learn from it.

Also, this symptom plays a crucial role in the detection of autism. It is known that such children display repetitive behaviors like hand flapping and other motor movements. Such behaviors can be observed and can lead to detection of autism. There are some researches on autism detection using accelerometers to detect repetitions in motor movements; however this remains an unexplored field.

3. LITERATURE REVIEW
In this section, we would be seeing how each of the above disorders and symptoms are overcome using some techniques that work as therapy and education for the children with Autism and other research in this field. In this section, we would be looking at the therapies using robots, virtual environments, and other computer technologies.

3.1 Role of Robots
Robot-Assisted Autism therapy is a fairly new field of research whose aim is to productively use robots in the therapy of autism affected children to better their lives. Research says that children with autism tend to display normal social interactions in the presence of robots. There are a number of papers that show this hypothesis to be true [8, 9].

Ricks et al. discusses the various therapy techniques that are being used with robots. Robots help autistic children in initiating communication. It has been observed that the children interacting with robots initiate interaction with the experimenter which is rarely observed in autism, and thus helps in instigating normal behaviors in autistic children. Robot-assisted therapy is also useful in helping the children in improving emotion recognition and joint attention. [9]

Ricks et al. also describe the various robot designs that can be used, ranging from humanoid to non-humanoid robots [9]. It can be said that the non-humanoid robots initiate more response from the autistic child; however they are not that efficient in transferring the skills learnt to other human-human interactions. On the other hand, the humanoid robots trigger less response from the autistic child as compared to the non-humanoid forms, but they are more successful in transferring the skills to other human-human interactions and thus play a better role in the therapy of the autistic child.

In his paper [8], Robin discusses the effect of robots on autistic children. Autistic children are attracted more to objects than to humans and thus they tend to play more with robots. When this robot interacts with the child, the child tends to develop a relationship with the robot. Thus it is important that robots when used in therapies should aid in helping the child to interact. The robots must act as “mediators” of social interaction and not “isolators” [8]. The use of robots should not make the autistic
children shun away from humans but rather should help in transferring the social skills from robots to humans.

Play is an important activity for a child’s growth. However, this same activity might become difficult for children with autism. While teaching social skills with the help of robots, the learning can be made fun, entertaining and motivating by introducing play. In [10], Ferrari et al. talk about a robot named IROMEC which is designed to teach autistic children various life skills like turn taking, imitation, sensory development, communication, etc. with the help of play scenarios.

To conclude, the robots are playing a major role in the therapy and education of the autistic children. Robots are found to be predictable and thus achieve more response from the children. However, it wouldn’t be enough to get a response from an autistic child during an interaction session with the robot. The challenge would be to see if the robots can help the children in learning and transferring their skills to other scenarios and interactions.

3.2 Virtual Reality Systems

Virtual Reality Systems are used in educating the children with ASD on how to interact, and recognize emotions and facial expressions. Virtual Reality Systems and Virtual Environments have a great potential in the education and learning of autistic children.

Children with ASD face problems in recognizing emotions, interpreting facial expressions, interpreting words with multiple meanings or metaphors, sarcasm, etc. Children with autism also tend to display weak gaze patterns. They don’t usually focus on the eyes of the person talking and tend to focus more on the lips and often miss other gestures and cues while doing so. [11]

Avatars can be created which closely resemble humans and thus provide a more natural and appropriate condition for learning the above mentioned skills which they lack.

There are a number of papers that show research of the use of Avatars for educating children with autism [11, 14]. Avatars are used in many systems to teach emotional facial recognitions, gaze patterns and also sometimes in the education of language structure wherein sentences are accompanied by contradictory facial expressions and the child needs to choose the right answer from the options given [11, 14]. These avatars generally resemble humans as much as technology permits, and are embedded in real life scenarios with backgrounds. These avatars have dialogues with the autistic child and the child is often put to test whether s/he was able to reach a proper conclusion of the dialogue with the help of the facial expressions, gestures and language [11].

Collaborative Virtual Environment (CVE) is a Virtual Environment where, in comparison to a normal Virtual Environment (VE) more than one person can experience the VE at the same time collaboratively [13]. In their paper [13], Rutten et al. experiment with a CVE using scenarios of café and bus. Here the autistic person needs to communicate and interact with the various avatars in the VE and do what is needed, i.e. in this case try to find a seat or order something. By using CVE, the child is brought as close to the real world as possible. In this case the interaction is actually between humans but is masked from the child by replacing the individual with an avatar [13, 14]. This shows how VEs can be modified to resemble real life situations and train autistic children to interact in real world, and also educate them in communication. The VE can be modified to adapt to different difficulty levels for the wide spectrum of ASD.

As compared to robots, Virtual Environments are more real like and provide a safe environment for the child to learn [12]. The child can be put in any scenario without the fear of offending or hurting anyone. However, here too like robots, it is essential that the learning be transferred to real life scenarios and to ensure that the child doesn’t get too used to the safe environment.

3.3 Other Computer Technologies

Apart from the use of robots and VR systems, there are numerous computer software and ubiquitous computer technologies that act as assistive systems that aid in the education and learning of the children with autism. In this section we will look at the various technologies that are used as of today in schools and other environments.

When the use of robots or virtual systems becomes infeasible, it is easier to use computer technologies and software since they are more accessible, for the learning and education of autistic children. Computer technologies do not need special environments and they can be installed in desktop computers or can be mobile. Thus, the use of computer technologies

Computer Based Training (CBT) widely uses WIMP (Windows, Icons, Menu, Pointing Device) interfaces. In their paper [15], Sitdhisangkan et al. compares the use of tangible user interfaces instead of a standard WIMP interfaces. They find the effectiveness of tangible interface over a conventional once for children with low functioning autism. They show that for the children with low-functioning autism, the use of tangible interfaces helps the children learn shapes more quickly and they find the interface to be easier to use than the standard WIMP interfaces. The tangible interfaces are more entertaining and thus get more attention from the child.

In [16], Piper et al. evaluates a tabletop game called SIDES which was developed using a DiamondTouch tabletop. There are a number of technologies which allow a one to one interaction with the computer, however SIDES creates a collaborative environment wherein four children play a game together. They share the goal of coming up with a shortest path
for the frog to travel from point A to point B. Games like these which are similar to the traditional board games, allow more interaction and help in inducing turn taking and joint attention in children with autism.

Helping Autism-diagnosed Navigate and Develop Socially (HANDS) is a project which consists of a toolset with many functions [17]. One of the important tools of HANDS is the Handy Interactive Persuasive Diary (HIPD). HIPD is an interactive calendar integrated into a mobile phone and is designed to support the development of social skills in teenagers and persuade them [17]. HIPD is considered as a Persuasive Technology.

In their paper [18], Tentori et al. describe a method for designing for Interaction Immediacy. A design of a social compass is explained which teaches the child about social interactions and whether it is appropriate to do certain actions. A child with ASD often doesn’t know how to interact and what would be the ideal thing to do in any situation. So, a device which can prompt the child on whether the actions are right or wrong would help a lot in the learning of the child. However, the design is in principle and its implementation could pose many questions and challenges.

Kientz et al. describe a decision support system called Abaris which is a type of Computer Supported Cooperative Care (CSCC) for the care of autistic children [19]. This system could be used collaboratively by everyone interacting with the autistic child who includes the therapists, teachers, consultants, teachers etc. It will ensure that there is a complete log of actions of the child and there is no missing data, and everyone can contribute to the treatment of the child in a more complete way than normal.

Computer Assisted Instruction sees a wide application in the education, problem solving, and learning life skills for children with autism. Some papers like [20, 21] elaborate on this technique. Moore et al. show how computers help more in building the vocabulary of the autistic child than a teacher [21], while Optiz et al. show a CAI system for teaching autistic children how to solve a problem and incorporates various difficulty levels [20].

4. FUTURE RESEARCH
Autism has a vast spectrum in which it affects the children, ranging from low-functioning autism (low IQ) to high-functioning autism (moderate to high IQ). The first and foremost thing to do before designing a system for children with autism would be to determine the level of the users and their abilities. There are two ways to go about designing a system for children with autism. One can focus on designing a system with enough flexibility to incorporate a wide range of disorders, or else one can design a system focusing on particular level of functioning i.e. either for the low-functioning autism or high-functioning autism. In general, it would be difficult to focus on a particular group of children since every child turns out to be unique in their abilities. It would be wise to be as flexible as possible.

Robots have been widely used in the therapy and education of autistic children. Though they’ve seem to do well in the experiments, one needs to know how effective is the use of robots in transferring the skills to human-human interactions. A study conducted over a long duration of time, to see the transfer effects of robot-human interactions to human-human interactions could reveal the effect of robots.

Different robots could be used over time ranging from non-humanoid to humanoid forms as per the comfort level of the child. Since it is seen that the autistic children get attached to the robots, one can have a ‘friendly Bot’ that can be portable. The child can play with it and at the same time learn too. The robot can teach skills to the child as a friend, can do actions which the child might imitate and thus learn in the process. However, it is essential that the child spend some time without the robot, wherein the true learning of the child can be evaluated.

Virtual Reality Systems don’t seem to be as feasible as robots. They are costlier and installation would cause a problem. They require the users to wear head gears and other equipments which might not be ideal for children. However, in spite of these shortcomings, VR Systems show much potential since they come the closest to reality. It would be wise to use CVEs at a later age to teach the children social interactions and communication, instead of using them in therapies at a younger age.

Other computer technologies can be used on an everyday basis to educate the child and teach them language skills. As an extension to the Arabis CSCC System, one can also have an associated expert system that can evaluate the progress of the child throughout and suggest areas of improvement and therapies using various technologies.

Though these therapy techniques are said to do well and teach social interactions, none of them are evaluated on the basis of their ability to teach in a long term. An experiment that can analyze how effective a technique is transferring the skills to human communications would be much needed. For this, a study with enough time spent interacting with humans must be conducted along with the therapies.

5. CONCLUSION
In this paper, we saw the various problems faced by the children with ASD. Life in general is not easy for such children and their parents. They tend to get aggressive, and giving attention and proper treatment at an early age becomes very crucial to the development of the child.

Since children with autism do not like the unpredictable nature of human beings, they find computers and technology more
appealing because they are found to be predictable. Taking advantage of this very nature, a number of technologies have been used for the treatment of children with ASD. All of the discussed technologies have done well and helped in the therapy of such children.

However, with technology becoming ubiquitous, it would be essential to ensure that the systems actually help the autistic children get involved in social interactions and not merely get involved with technology.

6. REFERENCES