Innovative technology to facilitate social intelligence in Autism Spectrum Disorders

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Autism Spectrum Disorders (ASD) are a group of heterogeneous neurodevelopmental disorders that severely compromise the development of social relatedness, reciprocal social behavior, social communication, joint attention, and language learning. The past decade has seen a surge in the use of technology to accelerate children's progress and support professionals and caregivers. Technology-Aided Instruction is now classified as one of the 27 intervention practices that have sound scientific evidence for increasing social skills in children with ASD [1].

Interacting with technology appears to engage persons with ASD more than interacting with other people. The technology advantage has been attributed to their often superior nonsocial skill in the ability to construct and analyze systems (e.g., math, physics, engineering, and computers) in the presence of impaired social intelligence. Baron-Cohen [2] explains the social intelligence challenges in persons with ASD as problems developing the cognitive and affective elements of empathy relative to mental age. The cognitive element is the development of a Theory of Mind (TOM) or the ability to attribute mental states (i.e., desires, beliefs, thoughts, imagination, and emotions) to oneself and others [2-3]. The affective element of empathy refers to having an appropriate emotional reaction to another person's mental states [2-3]. Challenges with empathy found in persons with ASD have been referred to as “the mind blindness theory of autism” [2]. Accessing another person's mind begins around 12 months of age when the child is capable of the joint attentional skills of showing, pointing and following another's eye gaze [4] which is delayed in children with ASD. As children get older, failures in the development of empathy manifest as difficulties understanding others' intentions, understanding others' emotions, taking another's perspective, understanding the appropriate amount of information needed to avoid ambiguities, to be informative, to be relevant, and to maintain the listener's interest [4-5].

Another aspect of cognition that impacts social intelligence is the drive for “coherence”. Coherence allows us to give meaning to our experiences by understanding them within a broader context [6]. Individuals with ASD often have a bias towards Weak Central Coherence (WCC) or the tendency to focus on the details, processing incoming information in a piecemeal fashion [6]. WCC makes it difficult to integrate information to achieve meaning about the world. They “can't see the forest through the trees.” A bias towards WCC makes it difficult for persons with ASD to understand a central “theme” and causal connections within a social situation [4]. WCC may also underlie problems understanding ambiguous language such as figurative language, idioms, metaphor, and jokes [4-5].

Social skills intervention for children with ASD needs to focus on improving Theory of Mind skills to help with the understanding of emotions, relevant social cues, perspectives, and appropriate responses [7-8]. In addition, it is helpful if the intervention facilitates coherence providing multiple ways for the child to gain meaning about the social situation. Social narratives and video modeling are two evidenced based practices that facilitate social understanding and coherence [7-8]. Social narratives describe social situations highlighting the relevant social cues, perspectives, and common responses [7-8]. Video modeling is a Technology-Aided Instruction that uses short video to provide a visual model of the targeted social skills [7-8]. Implementing these interventions in combination through humanoid robot technology can have several advantages over human to human communication when facilitating Theory of Mind and social skill [9].
RoboKind has spent 2 years creating 8 modules that constitute approximately one year of therapy that the robot delivers in varying dosages. The robot delivers social narratives and interacts with a tablet which contains videos of the relevant social skills. The robot asks the children questions that they can answer through the tablet to test understanding. This first course was written by Dr Pam Rollins and Michelle Mc Farlin who are associated with the Callier Center for Commutative Disorders at the University of Texas-Dallas, and Dr Caroline Garver who is the Director of the Autism treatment center in Dallas that treats both live in and day residents.

The thrust of these modules is to improve core social and Theory of Mind challenges described above (i.e., understanding the meaning of emotions, understanding relevant social cues, and appropriate social interactions from different perspectives). The robot is helping the child to function better in the world. One of the huge advantages is that many of the students require a lot of repetition to acquire and maintain these difficult Theory of Mind skills. The robot makes it possible for students to repeat a lesson with an entity that is patient, does not get frustrated or angry. The failure of a lot of therapy is that the staff or therapists are not available for the repetitions needed for the child to learn.

University researchers are increasingly using Robots to develop accessible, quantifiable and individualized intervention to address social skills in children with ASD [9]. Children with ASD are more engaged with robots and show measurable increases in sociability [9-11]. Robot technology is now moving out of the universities and into the province of the end user. Technology breakthroughs now make it affordable for schools, therapist and individual parents to purchase humanoid robots that can deliver evidenced based social skills intervention for children with ASD. Below is a summary of some of the important advantages using a humanoid robot.

1. The Robot creates tremendous engagement and excitement with children with autism. They like working with it.

2. The robot never gets frustrated or mad and has tremendous patience.

3. The robot can deliver TOM intervention created by PhD's knowledgeable about ASD with perfect fidelity. A therapist, teacher, aide or parent can follow up but the robot can work at a higher level with material than most staff.

4. One of the most important things with many children with ASD need is program repetition to both acquire and maintain skills. Many need the same lesson 5, 10, 20 times to sink in. The robot can do that and allow for real progress at the child’s own speed.

5. The initial material we have developed is an entire choreography using the robot and a tablet. It uses evidenced based practices (such as social narratives, video modeling, visual supports and the principles of ABA.). It focuses on two areas. Showing/explicating appropriate social behavior and responses and teaching and understanding the meaning of emotions and expressions. The robot has full facial expressions that play a part in the lessons. The robots expressions act as a bridge for the child to understand emotions in humans in a non threatening manner. The child interacts with the robot and the tablet. He can be completely non verbal and answer questions on the tablet using visual supports and the robot will respond. For each lesson we have filmed about 50 5-10 second scenes, first we explicate the concepts through video modeling and then test child’s knowledge and understanding as the child choses whether the children in the scene acted appropriately. We feel that the initial lessons are such that children throughout the spectrum will benefit.

6. In addition to delivering the material and linking with the tablet, the robot has advanced facial recognition software. With the benefit of an NSA grant we have developed a software program called Compustion. This enables the robot to measurer the frustration level and interest of the child, changing the subject and helping the child with emotional regulation strategies such as taking a break when necessary. It truly adds to the effectiveness of the Robots lessons.
7. The facial recognition software also allows for the robot to create data on each session which humans can’t readily do. For instance the robot can measure the percentage of time the student looked at the eyes or face as opposed to the mouth or chest. It can record the percentage of frustration or anger or apathy in a lesson. We feel over time the data output will relate to the progress the student is making over several variables and be important in accessing strategies and future actions. We think parents will find real data important as well.

8. The robot will also record the tablet answers as far as right and wrong and even the speed in which they are made. That means the robot is continually taking data for the clinician to evaluate at a different time.

9. The robot can record each session to be evaluated by others.

10. The initial material has about 120 symbols associated with core vocabulary for the child. This allows for progress with all levels of verbal and non-verbal children as well as further re informing certain ideas. These symbols also appear on the screen on the robot's chest as the word is spoken by the robot allowing for an incredible re enforcement. (The symbols are synchronized with the robot's words so that the child is learning in more than one modality. Many kids with ASD are better processing words when they are combined with visual symbols)

11. The Therapist has full control of the robot and the sequence of the skills being taught so as to compliment the Individual Education Plan for a particular student

Using a humanoid robot to facilitate core social and Theory of Mind skills expands the bandwidth of the therapist. It allows the therapist to elaborate on what each child is learning without having to spend time teaching the initial lessons which need to be done in great repetition. Also because children with ASD tend to find robots more engaging and motivating than humans [9-11], lessons focusing on core social and Theory of Mind challenges are integrated faster.
Reference


