Using Humanoid Robots to Foster Social Skills in Children with ASD

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Autism Spectrum Disorder (ASD) is a group of heterogeneous neurodevelopmental disorders that severely compromise the development of social relatedness, reciprocal social behavior, and communication. It is considered a spectrum disorder due to the diversity of symptoms, skills, and disability. Nonetheless, persistent deficits in social communication and interaction are the core features of ASD. An estimated 1 in 68 American children (1 in 42 boys and 1 in 189 girls) are affected with the disorder. The Centers for Disease Control and Prevention[1] report that the prevalence of the disorder has increased twenty-fold in the past 40 years, with a 30% increase in the past six years. While there is no cure for ASD, social skills intervention can improve the social competencies of children and adolescents with ASD, thereby minimizing the core features of the disorder.[2]

In response to the highly specialized needs of this population, researchers and clinicians are grappling with innovative methods to teach social skills to children with ASD. The past decade has seen a surge of technological advances and improved affordability. More recently, several social robots have been developed, which has created the possibility of robot-assisted therapy.[3]

Robots are a promising tool to facilitate social and communication skills in children with ASD. They are simpler and more predictable compared to humans and appear to be an intrinsic motivator.[4,5] Many children with ASD show more social engagement when interacting with a robot compared to when interacting with humans [6,7] or other devices.[3] Further, children with ASD have been found to speak more to an adult partner when the co-therapist was a robot compared to another human or a tablet.[4,5]

To our knowledge, the RoboKind Milo R25 robot is the only robot with a fully integrated social skills curriculum (i.e., robots4autism). robots4autism's innovative robot-generated instruction teaches social and emotional understanding by integrating several different evidenced based practices. Rollins & McFarlin[8] found that school aged children with ASD have a high level of engagement (i.e., they look at and/or gesture toward, initiate comments, make contingent responses, or engage in an activity) with Milo when he delivers lessons.

There are several reasons why children with ASD may be engaged with Milo. First, Milo has a simple design with exaggerated facial features – these are the attributes of robots that many children with ASD seem to prefer.[9] Second, there is consistent evidence that children with ASD have impaired and/or slower processing of auditory stimuli, particularly speech.[10] Milo's synthesized speech is 20% slower than human speech, which may provide children with ASD additional time to process the auditory speech stream. Finally, during lessons, a 2.4-inch LCD touch screen on Milo's chest displays, picture symbols of core vocabulary that coincide with Milo's speech (see **Figure 1**). This simultaneous pairing of picture symbols with Milo's speech enhances comprehension of the material. [11, 12]

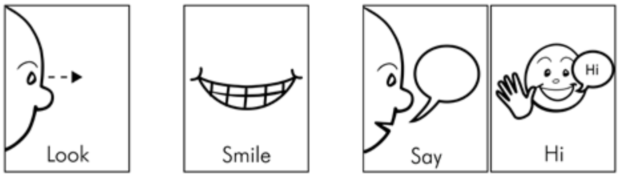

Figure 1: Visual support using picture symbols from the robots4autism curriculum.

While interacting with a robot may have its advantages, the ultimate goal is to generalize social understanding to interactions with humans. Vernon, Koegel, Dauterman, & Stolen[13] suggest that the combination of motivational and social intervention components can create meaningful changes in social function. Further, the reciprocal and interactive nature of social robots may serve as a social mediator and bridge to interactions with humans.

This idea was supported in a recent single subject design study.[14] Specifically, the author found a four-year-old boy with ASD was able to generalize information from the robots4autism greeting lessons to adults in his preschool class. In a single subject experimental design, each child serves as their own control by receiving both no treatment (baseline) and treatment conditions. This research design is particularly appropriate for defining evidence-based educational practices.[15] The participant, C, was enrolled in a University-based preschool program where graduate students in Communication Disorders help maintain a one-to-one clinician-to-child ratio. Greeting was omitted from the classroom goals and the graduate clinicians and parents were blinded from the objectives of the study. The robots4autism lesson targeted the verbal and nonverbal components of saying “Hi.” Specific target behaviors were (1) look at the other person, (2) smile, and (3) say “Hi.”

During the study, the child was brought to a quiet room twice a week for 15-20 minutes. During baseline (weeks 1-4), the child worked with Milo on identifying emotions (i.e., Happy, Sad, Angry). During the intervention (weeks 5-10) the child worked with Milo on the first greeting lesson (i.e., look, smile and say “hi”). Results of intervention were examined in terms of how C generalized the Robot delivered lessons into the classroom situation. Therefore, generalization data C’s ability to look, smile and say “hi” was collected each morning when he entered his classroom. C was given the opportunity to respond to four different graduate clinicians’ initiation of “hello”.

Figure 2 displays C’s use of the verbal and nonverbal components of greeting. The percent of opportunities C looked at a clinician, smiled and said “hi” (y-axis) was graphed by the week number (x-axis) across baseline (blue line) and two generalization phases (red line and green line respectively). In phase one, C received no additional support when responding to a graduate clinician’s greeting. In phase two, if the C did not respond by looking, smiling, and saying “hi” the graduate clinician silently held out picture symbols used in the robots4autism greeting lesson (**Figure 1**) in order to create a bridge from the robot-led curriculum to the classroom. Effectiveness was measured by percentage of non-overlapping data points (PND). The intervention with robot was minimally effective for generalizing to the classroom without added support (PND=.66) and highly effective for generalizing to the classroom when visual supports were added (PND=100). These results are striking when considering C was only receiving a half hour a week of intervention on greeting starting at week 5. In addition, C’s father reported that C was saying “hi” to more people at home.

While robots like Milo are not intended to replace human-led intervention, existing research shows that humanoid robots are an intriguing tool to help children with ASD. Organizations have made strides to make this intervention more accessible because it has high potential to improve social and communication skills. Programs like robots4autism are designed to provide individuals with skills that can be translated into their daily lives — a priceless gift for students and their families.

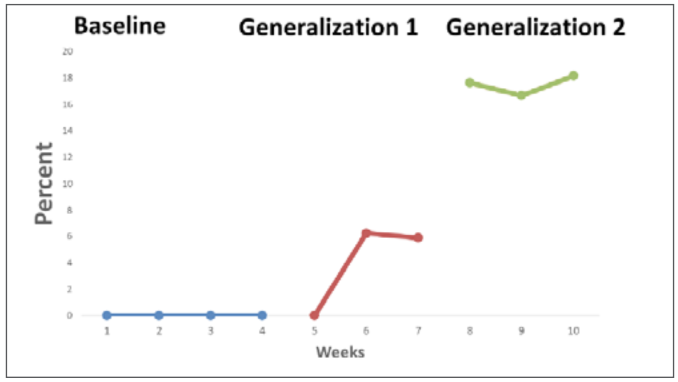

Figure 2: Percent C generalized the robot delivered lesson of (look, smile and say “hi”) when greeting across baseline and two generalization phases

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