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# Using Lego Robots to Estimate Cognitive Ability in Children who have Severe Physical Disabilities

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## Abstract

**Purpose:** To determine whether low cost robots provide a means by which children with severe disabilities can demonstrate understanding of cognitive concepts.

**Method**: Ten children, ages 4 to 10, diagnosed with cerebral palsy and related motor conditions, participated. Participants, had widely variable motor, cognitive and receptive language skills, but all were non-speaking. A Lego Invention[1] “roverbot” was used to carry out a range of functional tasks from single switch replay of pre-stored movements to total control of the movement in two dimensions. The level of sophistication achieved on hierarchically arranged play tasks was used to estimate cognitive skills.

**Results:** The 10 children performed at one of six hierarchically arranged levels from “no interaction” through “simple cause and effect” to “development and execution of a plan”. Teacher interviews revealed that children were interested in the robot, enjoyed interacting with it and demonstrated changes in behavior, and social and language skills following interaction.

**Conclusions:** Children with severe physical disabilities can control a Lego robot to perform un-structured play tasks. In some cases, they were able to display more sophisticated cognitive skills through manipulating the robot than in traditional standardized tests. Success with the robot could be a proxy measure for children who have cognitive abilities but cannot demonstrate them in standard testing.

## Introduction

Typically developing children learn cognitive, social, motor, and linguistic skills through manipulation of objects, often in a play context. Children who are unable to independently manipulate objects due to physical disabilities often cannot engage in play activities like their able-bodied peers, and as a result, the quality of their play may be compromised. In the long run, this may have substantial detrimental effects on their cognitive, social and linguistic development. The use of robots may offer a partial solution by providing an opportunity for children to choose how to interact with their environment, to exert some control over the activity, and to manipulate three-dimensional objects.

Traditionally, children with disabilities have experienced limited success in using robotic manipulators for educational tasks or Activities of Daily Living (ADLs) because most rehabilitation robots have been designed for adults, and their control requires relatively high-level cognitive skills that exceed the developmental level of younger children [1]. Recently, however, several investigators have attempted to address the issue of cognitive complexity by creating a hierarchy of control schemes, allowing children to progress from simple to more complex tasks[(2,3].

In addition, various investigators have also begun to use robots specifically for play and for educational and therapeutic access by children with severe motor and cognitive disabilities. One example is CosmoBot, a robot designed to engage children with disabilities in play, which has been used to encourage children to perform physical therapy [4]. The child can cause the robot to move its head and arms or move across the room by moving his or her own body Another example is the PlayRob system, built specifically for manipulation of Lego bricks [5-7]. Children can choose a brick, guide it to position and place it. In a trial with three children without disabilities and three children with disabilities, the study determined that the children enjoyed the activity, but that mapping the required input movement to desired robot movement was difficult for users who use scanning as a method of selecting input. . Subsequent User trials of 10 to 15 children with varying physical, mental and vocal abilities indicated that performance relative to placement time and accuracy improved, more of the play area was being used, the trajectory from picking up a Lego brick to placing it was reduced, and the complexity of the finished Lego models increased.

Some of the research has successfully used robots to demonstrate previously unmeasured cognitive skills, even in very young children. In a previous study six disabled and three typically-developing children, all less than 38 months in age, pressed a switch to make a Microbot educational robot bring an object closer to them but did not press it when the object could be reached [8,9]. Thus, by discriminating when they needed to press the switch and when they didn‟t, the children demonstrated the cognitive skill of tool use. Using an adapted industrial robot four children aged 6 and 7 who had severe cerebral palsy carried out a structured play task with an adult [10,11]. The children performed a series of multistep tasks by activating one or more switches to uncover a hidden toy. The robot task was more motivating, and the children focused on it longer than with other single switch activities. An expanded study, using the same tasks and a Rhino XR-4 robotic arm was carried out with twelve children aged from 6 to 14 who had severe physical disabilities who used the robot in their school for a period of four weeks [12]. The majority of the children in the study had increases in their performance after using the robotic arm. Teachers noticed differences in overall responsiveness, amount of vocalization and interest (i.e., increased attention to tasks) for children who used the robotic arm. The children‟s reactions to the robot were very positive and the robot tasks were more motivational (generated more interest and excitement) than single switch tasks with toys, appliances and computer-based activities. Overall, these studies showed that using the robot revealed children‟s skills that had not been previously observed and altered parents and teachers perceptions of the children‟s cognitive abilities.

Robots have been used successfully to allow children to participate in school based tasks that would otherwise be closed to them. a prototype interactive robotic device was used by two groups of children, four in pre-school (2 to 4 years old) and five in elementary school (5 to 9 years old), all having moderate to severe physical impairments, and five also with cognitive delays [13] The number of times they picked up a toy, and the number of actions with the toy , were tracked. The pre-school children were attentive, and all picked up and acted on the toys but to varying degrees.. The elementary school children had more cognitive problems and were less attentive and did not understand the multi-selection user interface, but two out of five of them demonstrated cause and effect. Kwee, [14, 15] adapted the Manus arm for use by children with cerebral palsy (CP) by altering both the physical control of the robot and the cognitive tasks required for control. The robot was used for various pick and place academic activities with six participants, 7 to 29 years old, all of whom had CP. Due to the severity of the physical disability of the participants, single switch scanning was used to select the direction of movement, and motion of the arm, and these adaptations resulted in control schemes that required significant amounts of training and practice in order to understand the cognitive aspects involved [1].

The Handy 1 Robot, originally designed as a feeding aid, was adapted for use in a drawing task to allow children to complete assignments in class alongside peers with minimal assistance [16]. Children could choose from a pallet of 8 colored felt pens and use them to draw on educational worksheets (for practice in joining lines, word and picture matching, mazes, and basic sums). A single switch scanning interface consisted of embedded lights in the pen pallet, four lights under the paper for directions, and three additional lights for up, down, and new pen. Tasks such as these are cognitively demanding, and widely varying levels of success were reported for the three subjects included in the study. A specially designed robot for access to science lab activities was trialed with seven students aged 9 to 11 years who had physical disabilities [17]. Children accessed the device with a 5-slot switch with a scanning display for selecting the robot mode. Investigators found that children needed two phases, first to learn robot functions, and then to use it for education activities. Access to the science and art curricula for students, aged 10 to 18 years, who had arthrogryposis, muscular dystrophy, and CP was evaluated with a multi-purpose workstation called the ArlynArm [18]. Two participants used the Arm for an art project (pasting items onto a collage) and three participants used it for three science projects (plugging in electrical wires to make a radio, mixing solutions, and planting seeds). The system was designed for children with good fine motor control, and required the user to manipulate one joystick for three-dimensional position, and another to change modes. There was a substantial variation in time for the users and one child with CP had considerable problems with the interface. Because of the cognitive demand of robot use, demonstrated success with the robot play tasks could be a proxy measure for children who have cognitive abilities but are unable to demonstrate them in standard testing. Use of the robot can also help to track changes in cognitive development by the child, and may contribute to improvements. A set of cognitive skills (causality, coordination of multiple variables, reflectivity, binary logic, and spatial relations) required for robot use by typically developing children was outlined by Forman [19]. This set provides a guide for comparison of performance by children with disabilities performing robot play tasks.

## Goal of Current Research

This study investigated the provision of a means for unstructured, spontaneous play for children with disabilities (i.e., the child controls a robot in two or three dimensions to accomplish play tasks). The use of robotic play as a means of assessing the level of their cognitive skills was explored.

## Materials and Methods

Ten children ages 4 to 10 participated in the study. Their disabilities were primarily cerebral palsy and related motor conditions. A Lego Invention2 "roverbot" vehicle, shown in Figure 1, was used. Robot programs were developed in a Windows environment using the Lego Robotics Inventions System 2.0 programming language. They were downloaded into the RCX controller (main brick shown in Figure 1) by an infrared linkage. The children controlled the robot through an adapted infrared remote control, shown in Figure 2. The adaptation of the remote allowed the child to control the robot through the activation of one or more switches, examples of which are also shown in Figure 2. . Two modes were used: stored movements and direct control. Stored movements were of several types. Some programs were set up to run to completion with one switch press (e.g., a robot that "danced" for 10 seconds and stopped a robot that moved and knocked over a stack of blocks then stopped). These were used at the initial stages of intervention. Other programs required the child to hit a second switch and/or the first switch a second time to stop the robot. Finally, some programs moved to a certain point after the press of the first switch and then waited for the child to press a second switch to complete the movement. Direct control allowed the child to turn left or right, go forward or go backward. In the initial stages a single switch connected to one motor allowed a child to draw circles on a robot that had a pen attached. In later stages, the child was able to "drive" the robot in any direction to complete play tasks or solve problems (e.g., navigate through obstacles). The cognitive skills identified by Forman [19] are shown in Table 1 organized by the youngest age at which they were evident in typically developing children. The robot tasks shown as examples at each of the 6 levels in Table 1 were developed using the various combinations of the child directed control schemes previously described. The initial tasks in Table 1 established causality and the understanding of the switch operation of the robot. Functional play tasks that involved manipulation with a purpose using the roverbot (e.g., bringing a favorite toy closer to the participant) were introduced at subsequent levels. As shown in Table 1, progressively more challenging tasks were used as the child demonstrated mastery of a particular level. Play objects that were important to the participant were included in the robot intervention sessions.

The placement of a child at a specific level in Table 1 was based on video tape review. For level 1, causality, we used the criteria of co-occurrence between attention to and activation of the switch and subsequently attention to the robot or toy expecting an action. We took a decrease in specific prompts (i.e., "hit the switch"), sometimes connected to more indirect prompts (e.g., "make the robot bring you the toy") to indicate an understanding of the relationship. For Level 2, negation, the criterion was the child‟s ability to stop at a specified location by releasing the switch. Errors such as overshooting a target and a high level of direct prompting (e.g., "let go of the switch") were taken as indications of lack o understanding of this task. Conversely, relying only on indirect prompts (e.g. "stop) and a decrease in errors were taken as indications of understanding of the task. To be successful at level three, binary logic, the child would typically have a decrease in the number of errors in switch activation (e.g., hitting the right turn switch when the left turn was required to complete the task). For coordination of multiple variables, Level 4, we evaluated whether the child was able to follow steps using two or more switches to attain a target with a decreasing number of errors.

For the last two levels in Table 1we evaluated the degree to which the child engaged in imaginative play activities (level 5) and the degree to which their activities followed a plan (level 6). For example for participant #01, various props (lake, forest, castle, mountain, and house) were placed in the play area establishing an obstacle course, through which she needed to navigate. She also was required to avoid driving into the lake or through a building. This participant had eight princess dolls that were her favorite toys. One activity with the princess dolls involved matching. Eight blocks corresponding to the first letter of each of the princesses were placed around the play area. The participant carried each princess to the corresponding block. More abstractly, pieces of food were placed around the play area and the participant carried the princess to the piece of food that began with the same letter as her name (e.g. Banana for Belle, Apple for Ariel, Rice cake for Rose).

Children's physical function was measured with the Gross Motor Function Measure (GMFM-66) [20]. Children's language abilities were assessed using the Peabody Picture Vocabulary Test (PPVT) [21]. These data are included in Tale 2. Some children were difficult to test with the PPVT. It is difficult to know if it was due to lack of ability on the child's part or on lack of ability on our part to adapt the test appropriately to meet each child's needs. We attempted to obtain an overall cognitive score for each child using the Leiter-R. [22] and the same difficulties were encountered, likely for the same reasons. A questionnaire on behavioral, social and language areas of performance was used in a structured interview with teachers and teacher assistants at the end of the each child‟s participation in the study.

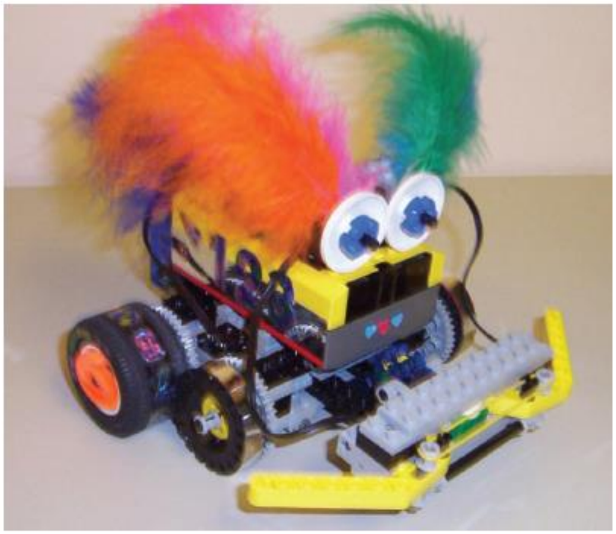

Figure 1. Lego roverbot.

Figure 2. Lego Mindstorms remote controller (left), adapted controller with switches (right).

Table I. Robot-related skills.

| | Skill | Definition for robot use | Age considerations* (typically developing children) | Lego robot examples |
|---|---|---|---|---|
| 0 | No interaction | Child displays no interest in the robot or its actions | NA | NA |
| 1 | Causality | Understanding the relationship between a switch and a resulting effect | <3 action is in switch, tried to use disconnected switches<br>>4 yrs understood switch made robot move | Use switch to drive robot, knocking over blocks with robot, drawing circles on paper by holding a switch down and turning robot |
| 2 | Negation | An action can be negated by its opposite | 4 yrs: begin to understand that switch release stops robot | Releasing switch to stop robot |
| 3 | Binary logic | Two opposite effects such as on and not on | 5–6 yrs: understood 2 switches with opposite effects | 2 switches turning robot right/left, or go and stop |
| 4 | Coordination of multiple variable spatial concepts-multiple dimension | Movement in more than one dimension to meet a functional goal | Age 5: could fine tune a movement by reversing to compensate for overshoot, etc | Moving roverbot to a specific location in two dimensions |
| 5 | Symbolic play | Make believe with real, miniature or imaginary props [28] | 6 yrs: child ID action in robot not switch, planning of tasks is possible | Interactive play with pretense, i.e. serving at tea party, exchanging toys with friends, pretending to feed animals all using robot |
| 6 | Problem solving | Problem solving with a plan – not trial and error, generation of multiple possible solutions | 7 yrs. Designed robot and thought about coordinated effects, planning was possible, can understand simple programs and debug | Changing strategies to solve a problem such as avoid an obstacle, changing task to meet the child's own goal, simple programming |

*From Forman (1986).

## Results

Because there was so much variability among the participants, analysis is primarily descriptive. The overall results are summarized in Table 2 including the participant's demographic information and scores on the standard language (PPVT) and physical function (GMFM) tests. The Brief IQ portion of the Leiter-R is listed in Table 2 for those children for whom we could obtain a score. The Level (age) of Robot Skill indicated in Table 2 reflects the highest level of the Table 1 tasks the child was able to demonstrate using the robot. As in table 1, the approximate age at which the robot skill was demonstrated in Forman"s [19] study with typically developing children is also indicated.

As an example of the data supporting causality (Level 1 in Table 1), Figure 3 shows a plot of switch activation, indirect prompts, attention to the robot and attention to the toy over 14 sessions for participant 08, one of the lower functioning participants. The prompts became more indirect (i.e., bring the toy (via the robot) rather than "hit your switch"). The switch activations tracked the prompts indicating that the child understood that he needed to hit the switch to bring the toy closer. He also attended to the toy increasingly while maintaining a consistently low amount of attention to the robot itself.

Data similar to that shown in Figure 3 were gathered to evaluate trends in errors such as failure to stop by releasing the switch Level 2 of Table 1) or incorrect switch pressed when two switches were used (Level 3 and 4). Successful navigation to a desired location was an additional criterion for Level 4.

An example of performance at level 6 was represented by one session with participant 01. One activity that the child was expected to participate in was to bring her toy princess through obstacles to the castle for a party; instead she decided to bring one of the forest trees to her, then decorate it. Stickers were used as decorations and they were distributed about the play area near the scene objects (house, castle, etc.). The participant maneuvered the roverbot to the pick up locations, and if there was more than one decoration at the location a partner scan technique was used to determine her choice. This was the first indication that she had developed her own plan and was determined to act on it.

The exit interview with the teachers comprised eight questions. The first 6 dealt with the children"s interaction with and response to the robot. The first question was "How do you feel the children reacted to the robotic arm? "For children who performed at level 5 or 6 on Table 1, teachers commented that they " reacted very well to it" and "they were eager to play with it" and "I thought it was fun for them" and "Absolutely loved it – loved it, loved it, loved it " They also indicated that the children looked forward to the robot sessions, "he talked about it, he"d come in and sign "work". He wondered if he was working that day with you" "she would get very excited and she knew what she had to do".

For the children who were in the lower range, Levels 1 and 2 of Table 1, teachers generally felt that it was hard to determine the children"s reaction but they felt the children were aware of it and that they showed interest in watching the robot. One teacher commented that they, "seemed to catch on that he was bringing his keys– I thought that was very deliberate – very" , but they also expressed caution, " because they are so low functioning it is hard to determine whether there is any cognition of anticipation for the activity". The children who were not engage did not interact, Level 0, a typical teacher comment was, " [participant] reacted more to the things that they were offering her" (toys, attention).

The second question was, " Did you notice any changes in the child's behavior during the course of this project? " For children in the high range teachers noticed a change in their attention and how the robot sessions were able to get them concentrating on a single activity for a prolonged amount of time . "I was amazed at you know even how much attention she was able to give to it." For children in the low range teachers felt it gave the children more "spontaneity to act when you request her to do something that she likes to do". No change was noted for participants 05 and 09.

Question 3 asked the teachers if they noticed any changes in social skills during the course of the project? For children in the high range teachers noted greater vocalization and verbalization, and they found that the participants‟ classmates were asking questions of the participants. Children in the middle range, Levels 2-4, seemed to respond more with the RAs as time went on. There was no change for children in the lowest range.

A parallel question asked, “Did you notice any changes in language skills during the course of the project.” Children in the high range engaged with other children more: "wanting to verbalize with the other children - she‟s more enthusiastic about wanting to actually say the words”. The teachers also reported that the participants would talk about the robot before, during and after the session: “…telling us that she was excited about working with Feathers [the name she gave to the robot]” . they would ask [participant] „was Feathers here?‟ and „what did you do with Feathers?. “…they would ask them [classmates that went to the session with her] the same thing – then the kids would try to explain what Feathers was doing so it was very, very interesting for her.” Children in the middle range became more somewhat verbal when they were using the robot. There was no change for children in the lowest range.

In order to gain a sense of the uniqueness of the robot we also asked the teacher if “ the children react differently to robots than to other single switch tasks?” The children in the high range seemed to realize that the robot could do more for them than a single switch toy, "it can do many different things rather than just hitting the switch and having the reaction of whatever it is that they are working with", “[she] …could take something from one point to another", "he was very interested in it because of the different thing that it could be". The children in the low range basically used the robot as a single switch toy. Children at the lowest level weren‟t even interested in single switch toys, "she is more enamored with the switch than she is with the actual activity", “she likes the noise of banging on the switch”

Two additional interview questions were aimed at the larger question of the use of the robot in the classroom and changes that might be desirable to make the robot more effective. Most of the teacher‟s comments regarding changes to the robot focused on making the robot more interesting and larger. For example one comment was, “Maybe a bit bigger, if you were going to use the robot for [participant]. Make it a bit taller, a bit brighter. Because … she can not see it that well …”

Teachers were generally enthusiastic about the potential use of the robot in the classroom. Some addressed the concept of giving the children with a disability an opportunity to demonstrate their abilities to their non-disabled classmates. For example, “ … being able to show them [her peers ]what she can do with pressing the switch and the robot and that would be really exciting.” And “I think it has a wonderful capability with connecting students with students – with our typical students with our regular students and in helping them to engage but its not an adult activity – it‟s something that‟s very attractive to our students in the classroom and it could be a connection to them for many activities to do with curriculum as well as problem solving, crafts and science.” Other teachers addressed the possible functional uses, especially for children who have more severe motor limitations, “we could be doing it during circle time … the kids could bring the name [for next turn] to another student.”

## Discussion

There was significant variation in motor, language and cognitive function in the participants, and extremes of all three domains were evident. Some children who had lower scores on the motor ability test (GMFM) Scores performed well on the language and cognitive evaluations and performed at higher levels of robot skill indicating that was motor ability was not directly related to cognitive ability. The variability in standardized testing was also evident in great variation in the skill demonstrated while using the robot.

Some children who were not testable on the standard IQ test were able to demonstrate some competence on robot skills. For example, L02, L08, and L11 demonstrated understanding of cause and effect; L12 was able to stop the robot by releasing the switch, demonstrating an understanding of negation and L04 was able to use two switches to direct the robot to knock over blocks. Participants L10, L06, and L01 were all able to use the robot for higher level levels.

The teachers reported that most children enjoyed using the robots, and they had increased attention to task and increased vocalization and verbalization with other children. In a number of cases, typically developing children from the participant‟s classroom and/or family and teachers aids and others were included in our robot sessions. There is a novelty effect of the robot and this helps to engage other students and make them part of the interaction. The inclusion of this "audience" was essential for developing and evaluating social interaction, and participants L01 and L11 thrived on it. For other participants (L06 and L12) the presence of other people was a distraction that impeded successful completion of functional tasks.

In Forman‟s [19] study he found that younger children believe that the action was in the switch they pressed and they were unable to associate the switch activation with robot movement. This led us to consider several progressions of focus of attention for the children in our study. We had anticipated that the sequence of focus with increasing skill of the child would be: switch-→ robot → toy (as representative of activity). What we found was that several of the lower functioning children had the sequence: switch- → toy 9and occasionally) → robot. In other cases children appeared to first focus on the toy, then the switch (due to significant prompting) and they largely ignored the robot. For some of our participants the focus of attention was on the research assistant with little attention to any of the other component. The fact that the focus of attention was variable across the participants and the sequence of attention also varied may be a product of the type and severity of the disabilities that each had. For example, participant L02 followed the sequence cited by Forman, i.e. focus on the switch as the source of the action. Participant L08‟s attention to the toy was probably related to his poor, primarily peripheral, vision. We adapted to this by using a very large red switch placed to the side of his head. However, he could not see the robot or the toy it carried until it was very close to him. In contrast, participant L10 was able to both the see the toy and robot from a distance, but had no interest in using the switch to cause the robot with the toy on it to come closer, even though the toy and robot were out of his reach. He displayed no understanding of the use of the switch even with significant prompting.

Problem solving was demonstrated in many ways. Avoidance of obstacles was one of the simplest, requiring only adequate left, right and forward control. Another basic problems solving situation was the confusion caused by the difference in control when the robot was moving away from the child as opposed to it moving toward the child. In the former case the left hand switch caused the robot to turn left. When the robot was coming toward the child the left switch still turned the robot to the left, but this was perceived as a right turn form the child‟s position since the robot was facing the child. Children had to figure out this change in control perspective in order to retrieve objects.

While undesirable, robot malfunctions (generally due to the robot being out of range of the infrared remote control signal or incorrect wiring of switches for intended functions) also provided some insight into how children did or did not problem solve. For lower cognitive levels malfunctions were just confusing and may have reduced interaction. However for higher levels there was a tendency to systematically trouble shoot the system by trying a switch again if the participant knew that they had made the right choice but the robot failed to respond. In two cases a shoulder shrug (L06) or communication through the mother (L01) indicated a question regarding what was going on. Occasionally the research assistant would connect the switches incorrectly, e.g., left switch hooked to turn right on control. For the higher functioning children this caused some confusion, but it led to increased interaction to try and figure out where the problem was and how to overcome it to complete the task.

For children who achieved level 4 or higher in Table 1, there is the possibility of using the robots educationally. Lego robots are being used as educational robots in the mainstream curriculum, and because the Lego programming software is computer based, children with disabilities can use them along with their peers [23]. Karna-Lin, Benarik, Sutinen, and Virnes [24] performed interviews with and observations of five groups of children programming Lego robots, some of whom had learning disabilities and mild cognitive delays. Their research goal was to develop methods to support the children with special needs in active learning, and study the impact on learning. They found that group working skills (asking advice, sharing ideas) increased in all five groups, they were motivated (more communicative and active), and had an opportunity to practice problem solving, logical thinking, perseverance, concentration, and tolerance of disappointment. Investigators concluded that "robotics can reveal new hidden potentials and skills" of students. Our results support this conclusion for students with both motor and cognitive disabilities.

### *Limitations of the Study*

There are few studies describing the use of robots by typically developing young children, especially in relation to cognitive demands placed on the child to operate and understand the robot‟s actions. This limits the applicability of the levels defined in Table 1, and emphasizes the need for further research in this area. Further development of the robot-related skill table is needed, but it appears to be a useful direction to pursue. Some children were difficult to test with the PPVT. We adapted the PPVT to allow children who had limited pointing ability to respond via eye gaze. It is difficult to know if lack of ability to obtain a score for the other children on both the PPVT and Leiter was due to lack of ability on the child's part or on lack of ability on our part to adapt the test appropriately to meet each child's needs.

We worked with the children for only four weeks. This may limit the generalization of the trends in our results. They may, however, be indicative of the potential for the robots to affect the children‟s behavior and to encourage social and language skills.

## Conclusions

Use of the robotic arm by children with disabilities gives the child a chance to demonstrate a range of cognitive skills by providing a versatile tool for presentation of tasks, problems and learning opportunities to the child. Children with severe disabilities can control a Lego robot to perform both structured and unstructured manipulative tasks. This use of robots increases interaction between students with disabilities and both their teachers and their non-disabled peers, resulting in more inclusive classroom activities. Robot use also draws students with physical and/or cognitive disabilities into robot-mediated tasks and increases their attention to and engagement in classroom tasks. A major result is that the use of robots by children with severe disabilities changes the perception of teachers and parents about the competency of the children. This is consistent with earlier studies [11,12, 25,26]. Using the robot, the children have been able to demonstrate that they possess skills that may be difficult for them to demonstrate on standardized tests. The impact on the children was amply summarized n this quote form one of the participants in response to the question: “What did you like best about the robot?”, she responded, “I can do it myself”. This sense of independence in play and learning is a major outcome for the children.

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