Assistive Technology Labs
3-59 Corbett Hall – University of Alberta Edmonton, AB T6G 2G4
Ph: (780) 492-5422 Fx: (780) 492-1696 Email: atlab@ualberta.ca

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Lego Robot Use By Children With Severe Disabilities

Albert M. Cook[1], Kimberly Adams[1,2], Norma Harbottle[1]
[1] Faculty of Rehabilitation Medicine, University of Alberta, [2]I CAN, Glenrose Rehabilitation Hospital, Edmonton, Alberta, Canada

Background

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. Research has shown that robots can provide 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. Previous work with infants having a mental age of 8 months or more, demonstrated that they use robots as tools. We believe that young children will be capable of controlling the robot to perform many play tasks. 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.

This study investigated the provision of a means for unstructured, spontaneous play for children with disabilities. The use of robotic play to track changes in cognitive development by the child was also explored. Finally, the contribution of the insights gained by robot use was applied to intervention planning.

Goal of Current Research

The overall goal is to enable children to make use of robots for spontaneous play (i.e., the child controls the robot in two or three dimensions to accomplish play tasks). A longer term goal is to understand the precise motor and cognitive skills that are needed by the children to use the robot for play and learning activities.

Participant

A single participant case study was conducted with a 10 year old girl who has spastic cerebral palsy, uses an AAC device (Vantage) and was in a fully integrated community school program, with a full time aide.

Methods

Two Lego Invention robots were used: a “roverbot” car and a robotic arm. The initial tasks were to establish that the child understood the operation of both robots through the use of switches that

controlled turning and movement (go/stop) in the roverbot and three dimensions (up/down, rotate left/right, grip (open/close) for the robot arm. A typical task included using two switches to draw circles using the roverbot with a pen attached. The next step was to add two more switches so that left, right, stop and go could be under the child's control. Since the participant had previously used a power wheelchair controller with a different control scheme, this caused confusion initially. The child also had to learn that when the robot was going away from her left and right turns were reversed from the case in which it was coming toward her.

Once basic operational skill was established a familiarity and planning phase was carried out. In this phase the child was asked to draw a circle around a target and to make specific shapes (i.e. a rectangle). During this phase the child also was introduced to a cooperative play activity in which one of the investigators controlled one of the three arm dimensions (usually up/down) and the child controlled the other two (turn base, and open/close gripper) to complete a task.

After the familiarization period, f**unctional communicative** tasks were introduced which involved functional manipulation and communication. Play objects which were important to the participant were implemented into to the robot play session. Initially, the participant participated in pick and drop activities involving eight Disney Princess Dolls. The participant maneuvered the roverbot to a pick up location at the far end of the play area, the research assistant placed the princess on top of the roverbot, then the participant maneuvered the roverbot back to the drop location close to her, where another research assistant removed the princess from the robot. It was interesting to note that the participant was very rigid about the order in which the dolls should be placed. The order from left to right corresponded to the year that each Disney movie was released.

In subsequent sessions, various props (lake, forest, castle, mountain, and house) were placed in the play area establishing an obstacle course, in effect. The participant carried the princesses from the pick up location close to herself to the various places of interest. In one session, the participant had placed exactly 2 princesses at each of 4 locations, and her aide felt that it demonstrated the participant's understanding of division.

Other activities 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 (Banana for Belle, Apple for Ariel, Rice cake for Rose, Cereal for Cinderella, Meat for Mulan, Strawberry for Snow White, Potato for Pocahontas and Juice for Jasmine).

The participant exhibited innovation during the sessions. For example, one activity that the participant was expected to participate in was to bring the princess through the 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. The participant vocalized often during this session.

Discussion

Over the course of the study, the participant's mother noted the following changes regarding the participant:

- She no longer must have toys in a specific location and order (including her Disney princesses) and has given up some control over situations.
- She is willing to take a toy to school for show-and-tell for the first time (she previously did not want to share her toys).
- She can roll over in both directions.
- She has become more vocal (says words unexpectedly and uses more vowel sounds and the Th and S sounds).

It may be possible that since the participant was given a means to control her environment using the robot, she felt she could give up some controlling behavior. However, maturity and other factors may have influenced this behavior.

Technical failure often caused confusion and frustration to the participant. If the robot failed to respond as expected, she was surprised at first, then confused, and then frustrated. Most of the failures were due to the robot moving out of range of the IR controller.

Conclusion

The participant was able to use robots to carry out tasks with real objects in a way that she could not do independently. This activity may have led to changes in her home and school life. She also displayed language and cognitive skills that had previously not been evident.