LEGO ROBOTS PROMOTING MOTHER-CHILD COMMUNICATION DURING FREE PLAY: A PILOT STUDY WITH A CHILD WITH SEVERE MOTOR IMPAIRMENT

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ABSTRACT

A single-subject case research was conducted as a pilot study in order to examine whether the child's communicative utterances and the mother's communicative functions change during free play in two conditions: without a robot and with a robot. A seven year old girl with spastic cerebral palsy and communication limitations and her mother participated in the study. Results indicate that the child's communicative utterances increased. This possibly indicated that she was being more motivated and engaged in playing. Mother's communicative functions indicated that mother was more responsive to the child's actions and initiative, and the mother-child interaction seemed to be more reciprocal when the robot was used by the child.

BACKGROUND

Cerebral Palsy (CP) is the most common childhood neurodisability (Eliasson, Krumlinde, Rösblad, Beckung, Arner, Öhrvall & Rosenbaum, 2006). CP affects the child's movement and posture. In severely motor limited children, fine motor skills for manipulation are reduced because of problems in motor control movements that involve head, trunk, arms and hands; thus, children have difficulties reaching and grasping objects (Eliasson, et al., 2006). Some children have communication problems because they may have difficulties producing understandable gestures and vocalizations (Pennington & McConachie, 2001). All of these conditions limit them to engage in free play.

Free play occurs when an activity is spontaneous, intrinsically motivated, actively engaged and self-regulated (Missiuna & Pollock, 1991). This kind of play has many benefits for children because it provides them the opportunity to discover their own capabilities, to try out objects, to make decisions, to comprehend cause-and-effect relationships, to learn, to persist, and to understand consequences. Children with cerebral palsy have a primary deprivation to engage in free play due to the physical impairment. In addition this deprivation can generate secondary social, emotional, and psychological disabilities. This is due to the children's lack of opportunities to interact, and practice their skills in order to experience mastery and control of the environment (Missiuna & Pollock, 1991).

There is evidence that mother-child play interaction is negatively affected by children's motor impairments (Hanzlik, 1989; Kim & Mahoney, 2004; Lieberman, Padan-Belkin, & Harel, 1995) and children's motor speech disorders (Pennington & McConachie, 2001). Mothers of children with cerebral palsy tend to be more directive during the interactions with their children than typically developing children's mothers (Hanzlik, 1989). Additionally, mothers of toddlers/children with cerebral palsy have exhibited a reduction of warmth and acceptance of their children during play interactions as their children grow (Kogan, Tyler, & Turner, 1974). Children with cerebral palsy are more passive, less responsive and more compliant when they play with their mothers than typically developing children (Hanzlik, 1989; Lieberman, Padan-Belkin, & Harel, 1995).

Robots have been used by children with motor impairment to manipulate play materials that generally are part of typically developing children's play. This kind of research has used tasks broken into a sequence of programmed movements that the child can activate by using one or more switches (Cook, Howery, Gu, & Meng, 2000; Kronreif, Kornfeld, Prazac, Mina, & Fürst, 2007). Additionally, robots have shown the potential to support adult-child interactions in which the adult is more conversational and less directive (Cook, Howery, Gu, & Meng, 2000).

Schulmeister, Wiberg, Adams, Harbottle, & Cook (2006) and Cook, Adams, Volden, Harbottle, & Harbottle (2011) used Lego Mindstorms robots for children's play activities. They reported that children reacted very positively towards the robots; some children increased their attention span, spontaneity and frequency of their smiles vocalizations, verbalizations while they used the robots. In addition, Mindess, Cook and Adams (2009) found that children with severe disabilities were motivated to communicate when playing with a robot and that playing with the robot appears to have had some positive effect on the children's communicative abilities. In all of these studies children played with the researcher.

Since robots have been seen to increase children's motivation and communication, they may have the potential to influence the mother-child communicative interaction during free play, helping the child to be more responsive and active and the mother to be less directive and more supportive.

PURPOSE

The purpose of this pilot study, a single-subject case study, was to answer the following research questions:

1. Does the number of vocalizations of a child with cerebral palsy increase during a play session when a robot is available for free play with their mother at home compared to a session without the robot?
2. Do the mother's communicative functions (e.g. direction of attention) change during a play session when a robot is available for free play at home compared to a session without the robot?

METHOD

Participant

The participants in this study were a 7 year old girl with spastic cerebral palsy and communication limitations (she was able only to say yes and no) and her mother. They live in Bogota, Colombia, hence they were Spanish speaking.

Materials

- A set of toys provided by the researchers.
- A Lego Minstorm (TM) car-like.
- The Lego infrared remote controller was adapted so it could be operated by three switches.

Setting

The study was conducted at the child's home.

Protocol

The standard starting position for both sessions was as follows: (1) The set of toys were located on the family's home dining table a distance of 30-50 cm from the child and the mother, (2) the child was in her wheelchair and her mother sat beside her, (3) a video camera was located in front of the mother-child dyad on the far side of the table in order to record the interactions. For the session with the robot, the starting condition was the same but the robot was located on the same table where the toys were located, and the three switches to control the robot were located on the child's wheelchair lap tray.

Procedures

There were two sessions. In the first session the child and her mother played with the set of toys only. In the second session, one week after the first session, the child and her mother played with the same set of toys and with the robot. A training session following a previous protocol (Cook, Encarnação, Adams, Alvarez, & Rios, 2012) on how to use the switches for operating the robot was done after the first session, but before the second session.

The mother was asked to play with her child as they typically play. Session 1 was 14 minutes in length, and session 2 was 11 minutes.

Videos were imported in to Morae (TM) which allows the user to code events. Occurrences when the mother spoke were translated into English by the investigator who was present during the sessions and is a native Spanish speaker. Also, the occurrences when the child indicated yes or no were translated. The mother's utterances were coded by function based on the coding scheme of Clarke and Kirton (2003) (see column 1 of Table 2). Additionally, the number of times that a given function was produced on behalf of the child was also tracked (i.e., if mom said a confirmation on behalf of the child).

The events were coded by two Speech Language Pathology students who did the first 5 minutes of each session together, then did the remaining session independently. The two raters compared each entry and came to consensus on discrepancies in codes. Since the sessions were of different lengths, the data was normalized to rate of utterances/minute.

RESULTS

Table 1. Child's utterances (rate/minute)

No Robot	With Robot	Difference
1.890319	4.229075	2.338755

As it is shown in Table 1 there was an increase of 2.34 in the rate of the child's utterance per minute in the Robot condition in comparison to the No Robot condition.

The mother's communicative functions changed between the two conditions as is shown in Table 2.

Table 2. Mother's utterances function (rate/minute)

Communicative Function	No Robot	With Robot	Difference
	Rate*	Rate *	Rate*
Commen-Label/Noun	1.75	0.70	-1.05
Confirmation	0.21	0.09	-0.12
Comment-Verbs/Action	0.21	0.97	0.76
Direction of Action	1.61	3.26	1.65
Direction Of Attention	2.66	1.59	-1.07
Denial	0.00	0.44	0.44
Positive Reinforcement	0.21	0.00	-0.21
Open-ended Question	2.03	1.41	-0.62
Yes/No Question	2.87	3.08	0.21
Request for clarification/Confirmation	0.56	0.53	-0.03
Response to open-ended question	0.35	0.00	-0.35
Self or Shared Expression	0.00	0.62	0.62
Grand Total	12.46	12.69	0.23
Endnotes *: Rate per minute			

In addition to what is shown in Table 2, during the whole session in the No Robot condition mother said 8 statements which were On Behalf of the Child, and with the robot she said 0. Similarly, mother's repetitions went down with the robot being 11 in the No Robot condition and only 3 in the Robot Condition.

DISCUSSION

Child's utterances went up in the robot condition, showing that the child was communicatively more active during the session with the robot.

Direction of Action (DAC) was higher with the robot which was opposite from what we expected. One explanation could be that the mother was giving direction about how to control the robot. In fact, about 32% of the times that the mother made a DAC she was trying to teach the child how to operate the robot (e.g. “Release the switch” and “Hit the switch to make it [the robot] to come here”). Another explanation is the strong tendency of adults to take the lead during play activities with children with disabilities in order to achieve their goals (therapeutic, educative) rather than the child’s interest and desires (Rigby & Gaik, 2007). Using robots has the potential to decrease the adult’s tendency but one single session is not enough to make considerable changes. As the child had only one training session about the use of the switches, the mother might have felt the need to teach the child how to operate the robot, which increased the DAC. An extended training period is required for further studies in order to give the required time for the child to develop adequate skills to operate the robot.

In addition, the frequency of occurrences of Direction of Attention (DAT) was less with the robot than without the robot. This is what we would expect because we expected that if the child was more independent during play, the mother would decrease her attempts to direct the child’s behavior. The content of the DAT utterances was different in the two conditions. While without the robot the mother tended to direct the child’s attention towards toys, in the Robot condition the mother tended to direct the child’s attention towards the actions the child was doing with the robot (e.g. “Look where you are making the robot to go”, “look at what you are doing”). It seems that in the Robot condition the mother responded better to the child’s actions and initiative, as the mother was describing what the child did instead of directing what the mother wanted the child to do during play.

The increase in Comment-Verb Action is likely due to the fact that with the robot there was more action during the play interaction’ thus, the mother was describing what the participant was doing with the robot. This may indicate that the child was playing and the mother was supporting the child’s play instead of directing the activity. The DAT is related to the Comment-Verb Action increase.

The fact that the mother's Comment-Label/Noun had less occurrences in the Robot condition might be because instead of picking up different toys and introducing them to the child or trying to reinforce concepts such as colors, numbers or name of things (as in the no-robot condition), she ‘hung-back’ a bit more and watched what the child was doing with the robot, and then commented on that action.

The decrease in positive reinforcement may be explained because during the No Robot, the mother tended to positively reinforced when the child did exactly what the mom asked her to do. This shows a maternal reinforcement to the child’s compliance which has been described as common in children with motor impairment (Hanzlik, 1989). Maybe as the child was less compliant during the Robot condition, the mother’s positive reinforcement decreased.

The decrease in Open-Ended Questions and Mother's Repetitions of Previous Remarks is likely related with the increase in Comment-Verb Action and Direction of Action. It appears that in the Robot condition the mother spent more time commenting on the child’s actions, teaching the child how to operate the robot and giving ideas about using the robot, and less time repeating commands or asking questions to the child in order to reinforce concepts (e.g. in the No Robot condition: “Where is the clown’s mouth?” and “Which is the yellow one [block]?”).

The reduction in speaking On Behalf the Child (OBC) is related to the decrease in Open-Ended Questions. Most of the OBC were mother’s responses to her own Open-Ended Questions on behalf the child (5/8=62%).

The Yes/No Questions increased and their quality changed. In the No Robot condition the mother was asking questions like “do you want to play with this?”, but in the Robot condition the mother’s questions were generally more varied and regarding the actions the child was doing with the robot (e.g. “Are you going to make it to come back?,”, “Do you think the robot is going towards those girls?”, “Do you want to do it again?”).

The increase in Self or Shared Expression shows that the mother-child interaction was more reciprocal during the Robot condition in comparison with the No Robot condition. This reciprocity has been stated as crucial for child’s development. Ferland (2005) states that the mother-child interaction is a cycle of reciprocity of responsive behavior mediated by the pleasure felt by the two members of the dyad. Thus, the robot seems to positively affect this cycle of reciprocity. This is an important element in the potential of using robots as mediators for mother-child interactions during play.

<u>Study Limitations</u>

Our sample was only one participant. Thus, generalization of the results is not possible. However, conducting this case of study research allowed us to have important insights about how the communication patterns between the mother and the child can change with a robotic intervention.

Another study limitation is the fact that we did not conduct inter-rater reliability between the two raters. This was intended as a pilot study to develop a system to use with other participants in further studies.

CONCLUSION

The results of this study showed that when using an adapted robot, a child with severe cerebral palsy increased her communicative utterances. This possibly indicated that she was being more motivated and engaged in playing.. The mother's communicative functions indicated that she was more responsive to the child's actions and initiative; she commented on what the child was doing instead of directing what she wanted her daughter to do during play. The communication appeared to be more reciprocal when the robot was present than when they played without the robot.

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