# Using Robotics to Assist in Determining Cognitive Age of Very Young Children

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**ABSTRACT**

In this study, we investigated the relationship between the developmental age of very young able-bodied children and their interaction with the Hero 2000 robot. This study will be used to design a protocol for disabled children using the Hero 2000 robot. Exceptional children are at a much higher risk of developmental delays because of their inability to control the world around them. We anticipate that robotics can be used to assist in the cognitive development of motorically disabled children from one to three years of age.

## INTRODUCTION

Infants learn by interacting with their surroundings. Very young motorically disabled children are at a developmental disadvantage because of their inability to manipulate the world around them. These children are at the risk of 'learning' that they are helpless and unable do for themselves (Brinker and Lewis, 1982). Technology can be used with early intervention programs to circumvent the process of "learned helplessness". It is known that disabled children as young as 3 months can make use of computers (Brinker and Lewis, 1982), and those of 7-8 months developmental age will use a robotic arm (Cook et al., 1988). These studies indicate that a mobile, talking robot with a robotic arm may be of assistance in the development of very young disabled children.

Piaget and other experts in child development have outlined a sequence of cognitive levels for infants and very young children which are exemplified by their interactions with the environment (Brainerd, 1978). In this study, the Hero 2000 robot was programmed to carry out a series of actions which correlate to cognitive developmental levels of very young children.

## EXPERIMENTAL DESIGN

The subjects for this experiment were one, two and three year old able-bodied children randomly selected from the CSUS child care center. The experiment used a standard Hero 2000 robot from Heathkit Zenith Company. The robot was activated to perform pre-programmed tasks by pressing a single tread switch made by Zygo Industries. These switches were selected because of their commercial availability, safety, and common use with the disabled population. The tread switch was connected to a National Instruments A/D board resident in an AT&T 6386 computer. A program written in National Instruments Lab Windows Quick Basic monitored the status of the switches, then sent a message out to the Hero 2000 remote console through the serial port. The remote console, in turn, sent a message out to the Hero robot to activate the pre-programmed activity specified by the switch press. The software program written in Lab Windows collected real time data during the experimental session by recording the switch press with the time of the switch press in an output file. The same file collected data regarding the reaction of the child to the robot. The experimenter observing the child pressed different keys of a keypad when the child looked at the switch, looked at the robot, smiled, or cried. These keys were monitored by the same Lab Windows program as the switches used to control the robot and key presses were recorded with the time that the data was collected.

The experimental protocol used a series of interactions between the robot and child which required an increase in the cognitive ability of the child. Three questions were asked in the five step protocol. First, does the child use the robot to do something interesting for him? Second, can the child use sequencing to carry out a task? And third, will the child use a series of switch presses to achieve the means to an end? These three levels of activity correspond to Piagetian developmental levels of 2-3, 4, and 5-6 respectively (Brainerd, 1978). The five steps were as follows: 1) to ensure that the child understood switch use, the child was shown a battery operated toy activated by pressing a single switch, 2) the same type of switch caused the robot to dump a toy out of a cup into reaching distance of the child, 3) there were two switches, one caused the robot to get the toy, the second dumped the toy from the cup, 4) a third switch was introduced which caused the robot to go across


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the room while the second and first switches obtained the toy, and brought it back to the child as before, and finally, 5) the third switch was pressed a number of times to get the robot to go all the way across the room as each switch press took the robot part of the way to the toy. The last step resembled a continuous mode of interaction where the child used the robot as a tool to achieve an end. To correlate the child's interaction to their developmental age, the Denver Diagnostic Screening Test and Parental Diagnostic Questionnaire were administered to the children. To ensure objectivity for the robot experiment, the results of the DDST and PDQ were blind to the experimenters until after the robot experiment was concluded. Although data from this study, collected in May of 1990, was unavailable for this paper, experimental data from the interaction of very young children with a robotic arm indicate that children will use the robot to do something interesting for them and will use the robotic arm as a tool (Cook et al., 1988).

## SUMMARY

Determining the relationship between the cognitive age of very young children and their interaction with a mobile, talking robot provides the framework necessary for developing the protocol which will provide disabled children an opportunity to independently interact with their environment. The robotic system, because of its adherence to the laws of gravity and three-dimensional space, gives the disabled child an opportunity to control their surroundings while learning concepts which may assist in their cognitive development.

## REFERENCES

Brainerd, C.J. *Piaget's Theory of Intelligence*, Prentice-Hall Inc., Englewood Cliffs, N.J., 1978.

Brinker, R.P., and M. Lewis, *Making the World Work with Microcomputers: A Learning Prosthesis for Handicapped Infants*, Exceptional Children, Vol. 49, No. 2, October 1982, pp. 163-170.

Cook, A.M. et al (1988). *Using A Robotic Arm System to Facilitate Learning in Very Young Disabled Children*, IEEE Transactions on Biomedical Engineering, Vol. 35, No. 2, February 1988. pp. 132-137.

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