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## Big lessons from small users: What Robots Reveal about Development in Children with Disabilities

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Typically developing children acquire cognitive concepts largely through exploration and interaction with their environment. Children who have significant motor disabilities are unable to engage with their environment to the same extent as typically developing children. Robots of various types have been used as a tool to provide an augmented exploration and discovery experience for these children. Studies have shown that children as young as 8 months are able to use a robot to act on the environment to accomplish a goal, i.e., they're able to demonstrate tool use behaviors with a robot. It is well known that through tool use behaviors children demonstrate early acquired cognitive and perceptual skills, and thus by observing children using a robot one can have a window to their cognitive development.

Tool use behaviors and their associated cognitive skills have been studied in typically developing children. These behaviors have been linked to the understanding of cause and effect, sequencing and prospective planning, since it not only involves understanding and perceiving properties of objects in relation to self goals and needs, but also the understanding of object properties in relation to each other, to serve self goals.

Our studies with children have shown that cognitive skills with a developmental sequence can be revealed through robot use. These studies have included typically developing and young children (from 8 mo to 5 years) and older children with moderate to severe motor and cognitive disabilities. Both physical and virtual robots have been used in these studies. Virtual robots that interact with virtual environments have been explored because physical robots require technological skills to assemble and program them, and remain expensive for some populations. This has provided information regarding the ways in which these children are able to demonstrate understanding of cognitive tasks. Replication of the Canada based studies in Lisbon, Portugal, and Bogota, Colombia, have revealed that while robot performance by these children is generally the same across cultures, there are some differences worth noticing, especially in children from lower socio-economic levels. For example, children from under-resourced house holds in Bogota , Colombia, were able to perform and reveal their understanding of the proposed tasks during the use of physical robots, but had difficulties in the use of the virtual robot. Little exposure to technology such as video games or computers was identified as a potential explanation of the differences between using physical versus virtual robots.