SUMMER, 2011

ON THE uptake

McGill

Hôpital juif de réadaptation
Jewish Rehabilitation Hospital

NeuroDevNet

WORKING TOGETHER FOR HEALTHY BRAINS

Childhood Disability LINK

Holland Bloorview
Kids Rehabilitation Hospital

VIRTUAL REALITY: REHABILITATION APPLICATIONS IN CHILDREN WITH DISABILITIES

Mindy F. Levin, PhD, PT
Professor and Canada Research Chair
School of Physical & Occupational Therapy
McGill University

In its broad definition, rehabilitation is the process of helping to improve function. These functions include abilities like walking and dressing oneself, cognitive abilities like paying attention in a school-room or planning the sequence of steps needed to play a game, and social abilities like managing one's anger or cooperating with others.

One tool that is emerging for rehabilitation that may be applied to all developmental areas is virtual reality. Virtual reality (VR) is a technology that allows individuals to experience and interact with computer-generated environments through their senses, including vision, touch and/or hearing. There are many types of VR environments, from simple computer-based games played on a computer screen with a mouse or other interface (non-immersive VR, see Fig. 1) to life-like scenarios created in a large room in which the user sees the environment all around them (fully-immersive VR – cave systems).

All of these types of VR environments have immersion, interaction and presence attributes. Immersion is the term used to describe how much the user feels like he or

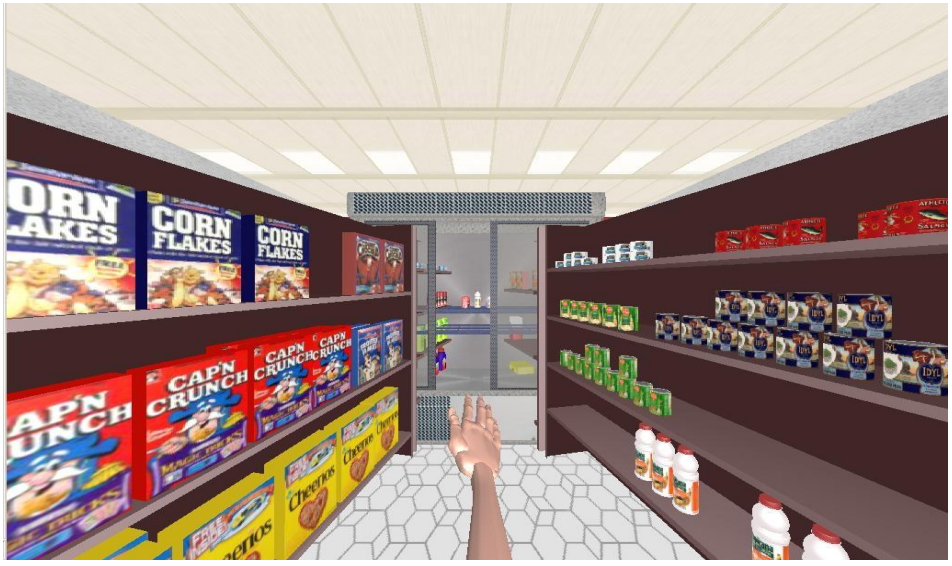

Figure 1. An example of a virtual reality "grocery store" environment for rehabilitation of the arm.

Presented by:

Childhood Disability LINK

This newsletter is presented by childhood disability LINK. Childhood disability LINK is a bilingual website Linking Information and New Knowledge on childhood disability to service providers and families. The website also focuses on enhancing the awareness and understanding of research on a variety of issues in childhood disability. This newsletter is also available in French. Please visit us at www.childhooddisability.ca.

she is inside a virtual environment that gives the illusion of being real. Interaction describes the extent to which the user can manipulate objects in the environment, like picking up a cup or hitting a ball. When the environment has a high degree of immersion and interaction, the user can feel a sense of 'presence' in the environment or a sense of really being inside the environment.

What are the advantages of VR?

The advantage of using VR for rehabilitation is that environments can be created in which the type of activity, practice and feedback can be tailored to the needs and abilities of the user for more effective motor learning and other rehabilitation outcomes. For children in particular, rehabilitation applications using VR provide opportunities for play that can be enjoyable, challenging and non-threatening. Such environments are thought to increase the child's motivation to be engaged in what they are doing, the child's control over their actions and the child's desire to practice new movements over a sustained period of time. These factors are important for better rehabilitation outcomes, for facilitating the brain's ability to form new connections and for the child's sense of self-control and self-satisfaction.

How effective is rehabilitation for children using VR?

VR is still a very young field and we are only beginning to gather evidence for the effectiveness of various VR applications in rehabilitation areas pertaining to children. The first reports published were mainly technical spreadsheets and descriptions of VR environments and applications. Currently, the evidence for effectiveness is encouraging but still not very strong in scientific terms. Early studies have focused on fundamental factors in the rehabilitation of children such as how well VR induces playfulness, how much it motivates children to do more exercise, and whether it is pleasurable or motivating. These characteristics of VR are especially appealing since children are often not very motivated to comply with conventional therapy that they do not think is meaningful or fun. Play is important in a child's development across all domains including motor skills, cognitive ability and social/psychological skills.

The effectiveness of using VR applications has been studied for improvement of a variety of skills. The most intensively studied areas are arm and hand motor skills, control of posture, visual perceptual skills, social skills and pain management.

Arm and hand motor skills

Several studies reported positive results with using different types of VR applications to improve movement of the arm and hand in children with cerebral palsy. Many of these studies used a video-capture 2D VR environment where the child played games while seeing him or herself on a TV screen. Others used commercially available game consoles or specialized computer programs that incorporated a large video display (Fig. 2) along with another piece of equipment like a sensor glove.

Visual-perceptual skills

VR training improved a child's ability to orient him or herself and navigate through space. However, for children with severe disabilities, positive results only occurred if the children were provided with cognitive training (e.g. exercises to improve mental sharpness and skills) prior to the VR interventions, and helped children with attention deficit disorders to concentrate better and learn to ignore distractions.

Social skills and pain management

VR has been used to create environments to assess and treat problems with a child's self-confidence, their ability to participate in play situations and their level of social acceptance. It has also been used to distract a child's attention during painful procedures and studies report that children were able to tolerate such procedures better when immersed in a VR environment.

Figure 2. An example of a custom-built virtual reality application in which the learner tries to make accurate and fast pointing movements to six different targets. The learner receives information about how well he/she is doing by various sounds and visual images as well as seeing the score that indicates how many successful movements are made. In this application, the child is encouraged to repeat the action many times to consolidate learning.

Although these studies have reported positive outcomes in each of these areas, the research is still in the early stages. At this point, it can be concluded that VR interventions are safe and feasible for use with children who have cerebral palsy. More research is needed in order to make definitive statements about the effectiveness of VR applications and to develop guidelines on the optimal treatment intensity needed to achieve various treatment goals.

Clinician's Perspectives

Darcy Fehlings, MD, MSc, FRCPC
Physician Director, Child Development Program
Holland Bloorview Kids Rehabilitation Hospital
Associate Professor, University of Toronto

Children and youth with cerebral palsy (CP) and their families are starting to explore commercially available virtual reality systems in their homes, such as the "Wii" system, as an adjunct to traditional rehabilitation interventions. In the Child Development Program at Holland Bloorview Kids Rehabilitation Hospital, some children with CP who range in physical abilities from using a wheelchair to walking independently, are reporting that they are playing with Wii sports games and are enjoying virtual golf, tennis, boxing, bowling and the fitness program. Children and parents indicate that they have fun playing the games and often play them for half an hour each day, and play in teams with their family members and friends. Benefits they are noting include improved balance when standing, better hand control, and enhanced "fitness". Many children also report that they enjoy the competetive aspect of beating their previous scores. Physiotherapists at Holland Bloorview are now starting to incorporate the "Wii" system into therapy. The Fit "n" Flex physiotherapy program, designed for children with CP who use walkers, incorporates the "Wii" boxing game into their circuit training program to work on standing balance and fitness.

Perspectives of Children and Families

Carmen is 11 years old and has spastic diplegia (Gross Motor Function Classification System level I). She has been using the Wii at home for the past 2 years. These are her comments:

"It is a good way to get active and have fun playing different games. I like that I can interact with the game. Yoga is a good way to stretch my muscles. I like the arm and leg strength activities and I am getting stronger. Soccer, penguin and tight-rope walking games have helped me with balance. I don't get bored playing the games because I can unlock new levels."

Carmen's mom comments that "Yoga from the Wii helped us become interested in Yoga. We now do mother and daughter yoga together in a community class as well as a yoga video."

Further reading and resources

* Website: International Society for Virtual Reality: http://www.isvr.org/

* Laufer, Y. & Weiss, P.L. (2011). Virtual reality in the assessment and treatment of children with motor impairment: a Systematic review. Journal of Physical Therapy Education, 25 (1), 59-71, 2011. http://web.ebscohost.com/ehost/pdfviewer/pdfviewer?sid=2d7707f2-427b-438b-90c8-962dc778c865%40sessionmgr14&vid=1&hid=14

* Levac, D. & Missiuna, C. An update on the use of virtual reality technology to improve movement in children with physical impairments, 2009. Canchild Centre for Childhood Disability Research. http://www.canchild.ca/en/canchildresources/VirtualRealityTechnology.asp

* Parsons TD, Rizzo AA, Rogers S, York P. Virtual reality in paediatric rehabilitation: a review. Developmental Neurorehabilitation, 12: 224-238, 2009. http://projects.ict.usc.edu/vrcpat/PDF/Parsons_Virtual%20reality%20in%20paediatric%20rehabilitation.pdf

* Rizzo AA. Virtual reality and disability: Emergence and challenge. Disability and Rehabilitation, 4:567-569, 2002.

* Sandlund M, McDonough S, Hager-Ross C. Interactive computer play in rehabilitation of children with sensorimotor disorders: a systematic review. Developmental Medicine and Child Neurology, 51:173-179, 2009. http://onlinelibrary.wiley.com/doi/10.1111/j.1469-8749.2008.03184.x/pdf

* Snider L, Majnemer A, Darsaklis V. Virtual reality as a therapeutic modality for children with cerebral palsy: Subject review. Developmental Neurorehabilitation, 13; 120-128, 2010. http://informahealthcare.com/doi/pdfplus/10.3109/17518420903357753