MOTOR LEARNING STRATEGIES IN PEDIATRIC PHYSIOTHERAPY

THE USE OF MOTOR LEARNING STRATEGIES WITHIN USUAL AND VIRTUAL REALITY-BASED PHYSIOTHERAPY INTERVENTIONS FOR CHILDREN WITH ACQUIRED BRAIN INJURY

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Abstract

Introduction: Children with acquired brain injury (ABI) receive physiotherapy interventions to promote motor skill relearning. Theoretically-driven motor learning strategies (MLS) may support therapists in this goal, but their use with this complex population is unexplored. Virtual reality (VR) games are popular interventions that may influence therapist use of MLS. A valid, reliable method to examine MLS during usual and VR-based interventions is required.

Purpose: To: 1) identify the active ingredients of VR interventions; 2) develop and examine the psychometric properties of an instrument to measure MLS use; and 3) explore physiotherapists' perspectives on promoting motor learning within usual and VR-based interventions for children with ABI.

Methods: A scoping review methodology was used to identify the active ingredients of VR interventions. Nineteen experts and clinicians participated in a content validation process to develop an instrument to measure MLS. Inter-rater reliability of the instrument was evaluated within 22 videotaped usual and VR-based physiotherapy sessions with children with ABI. Six therapists participated in qualitative interviews about these interventions.

Results: The scoping review identified 11 active ingredients of VR; 6 related to motor learning theory. The Motor Learning Strategy Rating Instrument (MLSRI) was developed. Inter-rater reliability was high (0.81) for usual interventions but low (0.28) for VR-based interventions. Therapists described the importance of considering intervention goals and child characteristics when promoting motor learning; VR was viewed as a complex, motivating intervention that influenced their use of verbal strategies.

Conclusions: A motor learning theoretical framework may be relevant to clinicians and researchers using VR in pediatric rehabilitation. Qualitative findings enhance understanding of how therapists promote motor learning in usual and VR-based physiotherapy interventions for children with ABI. The use of MLS can be measured reliably within usual interventions, but further instrument refinements are required to rate MLS use within VR-based physiotherapy for children with ABI.

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I dedicate this dissertation to my mother, Sally Batstone (1944-2002), whose memory continues to inspire me to strive for great things.

Preface

The following summary details all author contributions to each of the manuscripts in the dissertation.

For all four manuscripts: Danielle Levac determined the research questions, provided the overall study design, drafted the ethics submissions, supervised the data collection, analyzed the data, interpreted the findings, and drafted the manuscripts. Dr. Cheryl Missiuna assisted with reviewing the ethics applications, refining the research questions and study designs, interpreting the findings, and provided editorial assistance with manuscript preparation.

For the manuscripts entitled 'Documenting the content of physical therapy for children with acquired brain injury: Development and validation of the Motor Learning Strategy Rating Instrument' and 'Reliability of the Motor Learning Strategy Rating Instrument within usual and virtual reality-based interventions for children with acquired brain injury': Dr. Virginia Wright, Dr. Laurie Wishart and Carol Dematteo assisted in refining research methods, interpreting findings, and provided editorial assistance with manuscript preparation.

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Rivard assisted in refining the research question, undertaking the analysis, interpreting the findings, and provided editorial assistance with manuscript preparation.

For the manuscript entitled 'Usual and virtual reality video game-based physiotherapy interventions for children and youth with acquired brain injuries': Dr. Patricia Miller assisted in determining interview questions, analyzing data and interpreting findings, and provided editorial assistance with manuscript preparation.

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Chapter One: Introduction

Acquired brain injury (ABI) is a leading cause of childhood disability (Campbell, Kuehn, Richards, Ventureyra, & Hutchison, 2004; Centers for Disease Control and Prevention, 2000). Physiotherapists who work with these children seek effective, motivating interventions that promote *motor learning*: retention, transfer and generalization of skills to daily life activities (Gordon & Magill, 2011). Motor learning concepts that can guide the content of physiotherapy (PT) interventions are emphasized because of their link to the neuroplastic mechanisms of cortical reorganization that underlie recovery from ABI (Kleim & Jones, 2008). While pediatric interventions that explicitly emphasize motor learning theories and strategies yield positive outcomes (Hoare, Imms, Carey, & Wasiak, 2007; Missiuna et al., 2010; Niemeijer, Smits-Engelsman, & Schoemaker, 2007), there are no evidence-based guidelines for application of motor learning strategies (MLS) for children with ABI. PT interventions increasingly involve virtual reality (VR) video games whose abundant, multi-sensory feedback may offer motor learning benefits, but may also influence therapist use of MLS. In order to better understand physiotherapists' application of MLS in both usual and VR-based interventions and explore whether MLS use influences PT outcomes, a valid and reliable measurement instrument is required. As such, this dissertation focuses on describing and measuring the use of MLS within usual and VR-based PT interventions for children with ABI.

The dissertation is comprised of four inter-related manuscripts (Chapters Two to Five) that resulted from a scoping review and two research studies completed as a component of the candidate's PhD program in Rehabilitation Science at McMaster University. The scoping review (Chapter Two) lays the foundation for exploring how integration of VR into PT interventions may influence therapist use of MLS by identifying the potential active ingredients, many of which are motor learning-based, through which VR could improve motor outcomes in children and youth with neuromotor conditions. Two manuscripts (Chapters Three and Four) describe the development, validation and reliability evaluation of an instrument that is designed to measure the application of MLS within usual and VR-based PT interventions for children with ABI. A final manuscript (Chapter Five) presents the results of a qualitative study exploring therapists' perspectives on promoting motor learning within usual and VR-based interventions for children with ABI. Three manuscripts have been published in peer-reviewed journals and the fourth is currently under review. Permissions to reproduce the manuscripts are stated in the related chapters.

This introductory chapter provides a review of the literature forming the foundation for asking the research questions. It includes an overview of the impact of ABI on children and youth, the content and focus of PT interventions commonly used with these children, and the rationale for studying interventions. This is followed by an overview of motor learning as a theoretical framework, a description of motor learning processes in children (with a focus on how these may be impaired by ABI), evidence related to pediatric motor learning-based intervention approaches, and issues with existing instruments that measure the motor learning content of PT interventions. The role of VR within pediatric rehabilitation (with description of the system of interest in this dissertation) is outlined, and the rationale for exploring the relationship between motor learning and VR is described. Lastly, the chapter provides a statement of the problem to be addressed and a summary of study objectives.

Impact of ABI on children and youth

Acquired brain injury (ABI) is defined as "damage to the brain, which occurs after birth and is not related to a congenital or a degenerative disease. These impairments may be temporary or permanent and cause partial or functional disability or psychosocial maladjustment"(World Health Organization, 1996). The definition excludes congenital development problems such as cerebral palsy (Toronto Acquired Brain Injury Network, n.d.) despite controversy over when a diagnosis of cerebral palsy can be made (Paneth, 2008). The high incidence rates and long-term physical, cognitive and psychosocial consequences of ABI place substantial demands on children, families, and health care resources (Brener, Harman, Kelleher, & Yeates, 2004; Cronin, 2001; Lash, 2004; Slomine et al., 2006; Taylor, 2004).

Children with ABI are classified as having sustained mild, moderate or severe injuries based upon their score on the Glasgow Coma Scale (GCS) (Jennett & Teasdale, 1981) at the time of injury (Zafonte et al., 1996). There is a variable nature of impairments after ABI, as the term itself describes a broad range of conditions, all of which have in common the characteristic "…fundamentally patchy nature of the injuries sustained" (Forsyth, 2010, p.557). Traumatic etiologies may result in additional multi-system sequalae. Impairments resulting from ABI can cause long-term functional limitations that are linked with restriction in participation in daily activities (Bedell &

Dumas, 2004; Galvin, Froude, & McAleer, 2010; Johnson, Dematt, & Salorio, 2009; Johnson, Thomas-Stonell, Rumney, & Oddson, 2006; Katz-Leurer, Rotem, Keren, & Meyer, 2010; Law, Anaby, DeMatteo, & Hanna, 2011).

Cognitive issues following ABI are frequent and potentially long-term, including impairments in memory, attention, language, and executive functioning processes (Anderson & Catroppa, 2005; Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2005; Muscara, Catroppa, & Anderson, 2008; Yeates et al., 2002) . Memory impairments can interfere with new learning, while attentional issues include difficulties following commands, distractibility, and inattention to tasks (Yeates et al., 2005). Executive functions include planning and problem-solving; impairments can result in impulsivity and disorganization when switching activities (Anderson & Catroppa, 2005; Anderson & Catroppa, 2005; Gerrard-Morris et al., 2010). In addition, behavioural challenges including disinhibition, irritability, restlessness, distractibility, and aggression are common (Slifer & Amari, 2009).

Recovering motor skills and improving mobility is an important goal after ABI (Ibey et al., 2010). Impairments in visual-motor control, balance, postural control, muscle tone, coordination, range of motion, muscle strength, and endurance may be common (Both, 2008; Chaplin, Deitz, & Jaffe, 1993; Katz-Leurer, Rotem, Keren, & Meyer, 2010; Kuhtz-Buschbeck et al., 2003). Although independent ambulation is usually regained, balance impairments often remain a barrier to functional mobility (Van der Schaaf, Kriel, Krach, & Luxenberg, 1997).

Outcomes after ABI not only relate to injury severity and mechanism, but also depend on age at injury, pre-morbid levels of functioning, and family and environmental factors (Johnson et al., 2009; Johnson et al., 2006; Taylor et al., 2001; Yeates et al., 1997). All of these factors are considered by physiotherapists when designing their interventions.

Physiotherapy interventions for children and youth with ABI

PT interventions for children and youth who have had an ABI are provided to improve gross motor performance, enhance high level strength, balance and mobility skills, facilitate functioning and adaptation to disability, and reintegrate into home, school and community activities (Dumas, Haley, Carey, & Shen Ni, 2004; Dumas, Haley, Ludlow, & Carey, 2004; Haley, Baryza, & Webster, 1992). Children who have recovered basic mobility after ABI typically want to return to participation in sports and leisure activities, making the relearning of higher-level balance and mobility skills involving balance and postural control, coordination, agility, speed and strength the focus of interventions (Ibey et al., 2010).

The variety of impairments and functional limitations in this population implies the need for individualized services (Galvin & Mandalis, 2009). Rehabilitation can be a lengthy process, beginning in acute care and extending to in-patient rehabilitation, school and community services, in which many different PT interventions can be used. Individual studies have evaluated the effectiveness of certain PT interventions at different stages of recovery, such as the use of an early intensive neurorehabilitation programme for children in a prolonged unconsious state (Eilander, Wijnen, Scheirs, de Kort, &

Prevo, 2005) or the effect of a home-based task-oriented exercise program (Katz-Leurer, Rotem, Keren, & Meyer, 2009). Reports in the literature document outcomes of in-patient rehabilitation after pediatric ABI (Dumas & Carey, 2002; Dumas et al., 2004; Dumas et al., 2004b; Haley et al., 1992; Haley, Dumas, & Ludlow, 2001). With respect to describing intervention content, a single retrospective study reported that therapeutic exercise, including gait training and aerobic capacity conditioning, was the most frequently provided type of in-patient intervention (Dumas et al., 2004). While several systematic reviews have appraised the evidence for specific interventions in adult ABI, (including constraint-induced movement therapy, which is based in motor learning principles) (Bland, Zampieri, & Damiano, 2011; Hellweg & Johannes, 2008; Teasell et al., 2007), informing practice guidelines, there are no guidelines to support choices about intervention content for children with ABI in any setting (Beaulieu, 2002; Both, 2008; Dumas et al., 2004; Haley et al., 1992; Teplicky et al., 2005). To evaluate PT intervention effectiveness, a better understanding of intervention content is required.

Rationale for studying the content of PT interventions

Limited understanding of the content of interventions is a recognized issue in rehabilitation (Whyte & Hart, 2003). For example, details relating to the content of interventions that are being evaluated in research studies are vital, otherwise the intervention cannot be replicated and the information has little practical use for clinicians (Damiano, 2009). Interventions should not be viewed as a ‘black box’. They are a complex integration of a number of different ‘active ingredients’: the key elements that are hypothesized to result in, or contribute to, treatment effects and outcomes (Whyte &

Hart, 2003). Describing these active ingredients is essential to building an understanding of why any particular treatment is different from others and how it might be asserting its effect (Whyte & Hart, 2003). This allows definition of mechanisms that can be isolated and studied (Blauw-Hospers, Dirks, & Hadders-Algra, 2006; Dumas et al., 2004). Whyte & Hart (2003) suggest that employing a theoretical framework to examine active ingredients facilitates the eventual testing of hypotheses that may advance or refute the proposed theories. The following section describes the theoretical framework of interest to this dissertation.

Motor learning theoretical framework

The frame of reference that will be used in this dissertation to guide the exploration of PT interventions for children with ABI is motor learning theory. As there is a large amount of literature on this topic, only the concepts most relevant to this work will be highlighted.

A primary goal of pediatric rehabilitation is assisting children to learn or relearn functional motor skills (Larin, 1998). Researchers and educators look to motor learning theories and research to support therapists in working towards this goal (Schmidt, 1991; Zwicker & Harris, 2009). Motor learning is defined as "a set of processes associated with practice or experience leading to relatively permanent changes in the capability for skilled movement" (Schmidt & Lee, 2011, p.327). The study of motor learning has increased physiotherapists' awareness of the difference between 'performance' and 'learning' by emphasizing that improved performance within a therapy session is considered to be learning only when the improvements are retained over time (Newell & Yeuo-The, 2001; Gottfried, 2001).

A variety of motor learning theories exist to explain how skills are acquired, each differing in consideration of the factors that underlie motor learning. These varied theories have influenced the ways in which instructors and therapists are encouraged to promote motor learning in clinical practice. The *closed loop theory* (Adams, 1971) emphasizes the role of sensory feedback, while the *schema theory* (Schmidt, 1975) proposes that repetitive, variable practice strengthens the formation of memory representations. In contrast, *ecological theories* highlight the interaction between perception and action and focus therapeutic attention on the learning environment (Schmidt & Lee, 2011). *Dynamic systems theory* emphasizes the relationship between subsystems of the individual, the environment and the task in learning new motor behaviours (Kamm, Thelen, & Jensen, 1990). This theory encourages therapists to consider which variables to manipulate to promote learning, emphasizing the learning context and the meaning of the task to the learner. Finally, the *cognitive effort perspective* promotes the importance of problem-solving when learning new motor skills, emphasizing the role of observational learning, decisions about amount and timing of feedback, and the importance of contextual interference in a therapy session (Lee, Swinnen, & Serrien, 1994).

Motor learning research explores how training can be optimized to promote the acquisition and retention of motor skills. This research has primarily focused on healthy individuals undertaking simple laboratory tasks, although work has been done with adult neurological populations within therapeutic contexts. Both have provided knowledge that can be applied by physiotherapists. The most direct translation of theoretically and empirically-derived knowledge is in the form of motor learning principles (formulated as guidelines) that inform the ways in which therapists should structure therapeutic practice to enhance motor learning. For example, a principle might suggest that practice should be intensive, that greater amounts of practice increase learning, or that task practice should be variable rather than constant (Schmidt & Lee, 2011). Since these motor learning principles are supported by evidence derived mainly from adult, non-clinical populations, pediatric therapists may have difficulty determining their relevance and transferability to their own clientele.

One of the key challenges for clinicians, educators and researchers interested in promoting motor learning is that there is no common terminology in the literature to describe application of motor learning knowledge by therapists within their clinical practice. Thus, selecting and defining terms like 'motor learning strategy' (MLS) and outlining a clinical decision-making process to describe these strategies in practice was a component of the critical thinking involved in this dissertation.

Neural plasticity: A neurophysiological mechanism of motor learning and relearning

In addition to motor learning theories, a strong rationale for exploring how PT interventions can promote relearning of motor skills comes from evidence relating to neural plasticity. Neural plasticity is a neurophysiological mechanism of motor learning in typical development and in relearning after central nervous system (CNS) injury

(Kleim & Jones, 2008). It is defined as "the ability of the brain to change in response to external stimuli, experience, or damage" (Boyd, Vidoni, & Daly, 2007, p.685). Animal and human studies demonstrate that experience can change neuronal connections and alter the strength and formation of new connections (Dancause et al., 2005). These changes can involve either recovery of the injured tissue or undamaged neural networks taking over the original function from the damaged area (Stein & Hoffman, 2003).

Skill repetition or strength training alone does not lead to neuroplasticity; rather, it is motor skill acquisition (as a function of motor learning) that drives changes in the CNS (Kleim & Jones, 2008). There is evidence that PT interventions after stroke can be structured to provide motor learning opportunities that drive the cortical mechanisms of neuroplasticity (Carr & Shepherd, 2004; Feldman & Brecht, 2005; Nudo, Plautz, & Frost, 2001). Important principles underlying these opportunities include using a task-oriented approach involving meaningful tasks, maximizing the learner's motivation to practice and incorporating abundant and high intensity repetitive practice (Kleim & Jones, 2008). While these principles are believed to drive neural plasticity, the specific dosing requirements required to achieve changes within PT interventions are unknown.

Motor learning in children and youth

The following sections review knowledge about motor learning in typically developing children and children with developmental or acquired neuromotor conditions (including ABI), present evidence for the effectiveness of motor learning interventions in pediatric rehabilitation, and provide the rationale for exploring physiotherapists' perspectives about how their interventions promote motor learning.

Motor learning processes in pediatrics

Children differ from adults in motor learning processes: they have a slower rate of information processing (Pollock & Lee, 1997; Sullivan, Kantak, & Burtner, 2008), lower attentional capabilities, and more limited spatial, verbal and learning memories (Karatekin, Marcus, & Couperus, 2007; Mantyla, Carelli, & Forman, 2007). During normal motor development, children's motor learning occurs over long periods of time as a result of abundant practice in a variety of settings. This process implies that therapy might be most effective if it incorporates the same type of problem-solving skills required in real life and if it involves caregivers who can carry over these skills to practice in the home environment (Gordon & Magill, 2011).

Given the differences in motor learning processes between children and adults, motor learning evidence and guidelines derived from study of adult populations may need to be implemented differently in pediatric interventions. For example, children may require more practice and feedback when learning a motor skill and a more gradual reduction of this feedback over time (Sullivan et al., 2008). While random practice is usually thought to be more beneficial for learning, younger children, children with neuromotor impairments, or those learning complex skills, may benefit more from blocked practice schedules. Because children's motor learning requires abundant repetition, interventions that provide a high intensity of practice and that motivate children's engagement may be beneficial. Finally, clinicians must interpret evidence in the context of characteristics of the learner, the task and the environment that also influence physiotherapist decision-making (Gordon & Magill, 2011).

The limited pediatric evidence base related to children with neuromotor conditions primarily concerns children with cerebral palsy (CP), as discussed on page 13. In comparison with typically developing children, those with CP require more practice repetitions, do not appear to benefit more from any particular practice schedule, and demonstrate less retention of learning after 24 hours (Garvey, Giannetti, Alter, & Lum, 2007). Knowledge of performance feedback may be important; one study demonstrated that children with CP benefited from the use of cognitive strategies such as attaching a label to a movement (Thorpe & Valvano, 2002).

Motor learning and relearning after ABI

Since ABI can occur at any age and within a developing system, children's abilities and challenges may evolve as the demand to meet new developmental requirements unfolds over time (Haley et al., 1992). Depending on the brain region that is injured, the neurons that are responsible for motor learning processes may be damaged at the site of injury or in other interconnected regions, and the processes of repair may impede the neurophysiological mechanisms of memory formation and learning (Kleim & Jones, 2008). To recover from an ABI, children must not only meet pre-injury functioning levels but must continue to develop and learn new skills, described as the need to 'hit a moving target' (Giza, Kolb, Harris, Asarnow, & Prins, 2009). Depending on age at injury, children may already have an internal representation of a motor skill to be relearned or they may be learning an entirely new motor skill. PT interventions need to promote recovery of existing skills, but also facilitate transfer and generalization of learning so that children can adapt their learning to new skills and environments.

Motor learning-based pediatric intervention approaches

Levac, Wishart, Missiuna, & Wright (2009) undertook a scoping review to identify the motor learning variables that are components of interventions for children with neuromotor conditions. The authors found that these motor learning variables were often defining components of the interventions or were used as a way to target generalization and transfer of learning. They also found that study reports often did not provide enough information to understand the role(s) of these variables within the intervention approach. Most interventions did not explicitly outline motor learning variable application. The authors called for more investigations to detail intervention content related to motor learning (Levac et al., 2009).

There is evidence that applying MLS in typically developing children and in children with CP influences motor learning outcomes. For example, a recent randomized controlled trial evaluated a 'motor learning coaching' approach involving the use of MLS compared with NeuroDevelopmental Therapy (NDT) in children with CP (Bar-Haim, Harries, Nammourah, Oraibi, Malhees, Loeppky, et al., 2010). As described by the authors, the NDT interventions focused on improving body functions and structures such as movement patterns and muscle tone, while the motor learning approach emphasized motor learning principles (Bar-Haim et al., 2010). The study found that both groups improved at 3 months post-intervention; but, at 6 months post-intervention, children who had received the motor learning coaching demonstrated significantly greater retention of functional skills and mobility in the community, while scores in these areas declined in the NDT group (Bar-Haim et al., 2010). Other intervention approaches that explicitly emphasize selection of MLS, such as constraint-induced movement therapy (Hoare et al., 2007), Cognitive Orientation to Occupational Performance (Missiuna, Mandich, Polatajko, & Malloy-Miller, 2001),and Neuromotor Task Training (NTT) (Niemeijer et al., 2007) have also demonstrated positive outcomes. Changes in patterns of brain activation following motor learning have also been demonstrated (Zwicker, Missiuna, Harris, & Boyd, 2011).

Little is known about how to use MLS within pediatric interventions (Zwicker & Harris, 2009) and there is a complete absence of evidence with respect to children with ABI. Evidence is needed in order to guide choice of MLS and to examine whether using these strategies impacts functional outcomes (Larin, 1998; Zwicker & Harris, 2009). Valvano (2004) suggests that motor learning knowledge can be adapted and modified for use in clinical populations for whom no motor learning-specific evidence exists, and encourages therapists to take each child's individual strengths and challenges into account to individualize treatment. She encourages therapists to consider theory and children's potential impairments in motor learning processes.

Therapist familiarity with motor learning theories

In 1992, Larin observed physiotherapists as they provided interventions for children with CP. She found that they used many MLS, and that the use of these strategies was related to therapist level of experience, with younger therapists applying more MLS (Larin, 2007). In qualitative interviews following the intervention sessions, the therapists demonstrated varying degrees of implicit and explicit awareness about MLS (Larin, 2007). To the author's knowledge, no other studies have documented or described the use of MLS within rehabilitation interventions. In highlighting the relevance and use of motor learning theories within pediatric practice, Zwicker and Harris (2009) suggest that theories may be challenging for therapists to operationalize in practice and that therapists may be implicitly applying these strategies without a link to their theoretical underpinnings. They argued for more conscious reflection by therapists about motor learning theory application in practice. Indeed, a survey of pediatric physical therapists in the United States found that therapists report needing more information to support them in the use of a motor learning approach (Hayes, McEwen, Lovett, Sheldon, & Smith, 1999).

Measuring motor learning in pediatric PT interventions

In order to understand the use of MLS in pediatric PT, a valid and reliable measurement method is required. Although several instruments exist to measure aspects of motor learning within PT interventions, none were appropriate for use in this dissertation. The Paediatric Physical Therapy Intervention Activities (PPTIA) data form was validated with children with developmental delays (Hashimoto & McCoy, 2009). This assessment, completed by the treating therapist post-intervention, documents types of activities, the amount of time spent on a specific activity, and interventions used in the therapy session. However, the use of “motor learning” is but one of 76 different activity items on the PPTIA scale. In an instrument to document the content of NTT, Neimeijer et al. developed a taxonomy of verbal actions directed towards improving motor learning in children with developmental coordination disorder (DCD) (Niemeijer, Smits-Engelsman, Reynders, & Schoemaker, 2003). While it provides a useful classification of some MLS, they are specific to NTT.

In contrast, the Motor Teaching Strategies Coding Instrument (MTSCI-1) was created to focus on the frequency of MLS used by physiotherapists within interventions for children with CP (Larin, 2007). The items demonstrated good to excellent agreement (as measured by Kappa scores) between 2 raters who observed videotaped intervention sessions. However, the MTSCI-1 form is complex to follow, does not include items relevant to more contemporary motor learning theories, and evidence for its psychometric properties is preliminary and has not been further evaluated. A new instrument is required that is relevant in content to usual and VR-based PT interventions for children with ABI.

Virtual reality within pediatric rehabilitation

The use of virtual reality (VR) is an active area of rehabilitation practice and research (Snider & Majnemer, 2010). VR involves the use of computer hardware and software to create interactive simulations, allowing users to engage in environments and actions that have similarities with the real world (Weiss, Rand, Katz, & Kizony, 2004). Many VR systems have been developed specifically for use in rehabilitation to improve movement skills. These are often expensive systems which are limited to use in research laboratories. In contrast, computer-based video games involving joysticks or keyboard controls are common daily entertainment for many children and youth. These two extremes have been united by the development of movement-based, low-cost and commercially available VR gaming systems, which have made VR technology accessible to clinical practice.

Nintendo Wii/WiiFit™

The VR system of interest in this work is the Nintendo Wii and WiiFit[1] . These entertaining and accessible gaming consoles use motion-sensing technology to detect acceleration and orientation, allowing the child to control games by means of movement and posture (Deutsch, Borbely, Filler, Huhn, and Guarrera-Bowlby , 2008). The Wii remote controller uses accelerometers that enable it to detect movements in three dimensions (Nintendo of America Inc., 2007). Game play with the controller can involve miniscule or whole body movements. An on-screen avatar (a visual representation of the self) mimics movements on screen. The Wii Fit is a pressure-sensitive balance board in which weight-shifting and changes in body posture control balance, strengthening, and endurance.

What is the relationship between motor learning and VR?

VR offers features with great potential to take advantage of principles that promote neuroplasticity and motor learning (Levin, 2011).VR video games are salient and meaningful tasks for children (Gordon & Magill, 2011), motivating them to participate in the repetitive activities needed to gain skills (Laufer & Weiss, 2011; Sandlund et al., 2009). Motivation may be particularly relevant for children in order to maintain attention and participation in rehabilitation (Laufer & Weiss, 2011). VR provides abundant, real-time sensory feedback about movement performance and results (Rizzo & Kim, 2005; Saposnik & Levin, 2011) and provides opportunities to target observational learning processes through engagement of the mirror-neuron system (Rizzo

[1] Nintendo of Canada Ltd. Suite 110, 13480 Crestwood Pl, Richmond, BC , V6V2J9

& Kim, 2005; Weiss & Katz, 2004). VR provides task-oriented training (Saposnik & Levin, 2011), promotes neuroplasticity by enhancing environmental enrichment (Rose, Brooks, & Rizzo, 2005), and provides opportunities for consistent and abundant repetition of tasks (Sveistrup, 2004). Wang & Reid (2011) suggest that virtual environments designed to mimic the real world lead to greater transfer and generalization. However, the extent to which researchers have emphasized these features by linking them to VR intervention outcomes requires investigation.

VR systems differ in the extent to which they can be manipulated by therapists. As a commercially-available gaming system, the Wii has minimal capability for therapeutic manipulation and may be challenging for rehabilitation use. Because VR interventions require therapists to make decisions about interventions and progress through different levels of the game or task, it is important to understand the role of the clinician in providing VR interventions, including the influence of VR on MLS use.

Evidence of effectiveness of VR interventions

With respect to the Wii, few reports exist to inform therapists interested in using these VR games within clinical practice. Empirical research is emerging in the adult stroke (Mouawad, Doust, Max, & McNulty, 2011; Nitz, Kuys, Isles, & Fu, 2009; Saposnik, Teasell, Mamdani,. Hall, McIlroy, Cheung, et al 2010) and pediatric (Deutsch et al., 2008; Wuang, Chiang, Su, & Wang, 2011) literature to demonstrate that Wii intervention protocols improve short term (1-3 months post-intervention) motor outcomes. Transfer of learning from virtual environments to real life activities has been demonstrated in pediatric studies (Deutsch et al., 2008; You et al., 2005). Apart from a pilot RCT, these are single-subject methodologies designed to demonstrate proof of concept, so the potential impact of the findings is limited.

For VR interventions as a whole, reviews of the existing published studies are positive about their potential to promote outcomes of motor performance in children with neuromotor conditions. However, with some exceptions, issues with the methodological quality of the early evidence limit the ability to make global conclusions about whether performance improvements during VR interventions translate to functional skills (Galvin, McDonald, Catroppa, & Anderson, 2011; Laufer & Weiss, 2011; Parsons, Rizzo, Rogers, & York, 2009; Sandlund, McDonough, & Hager-Ross, 2009; Snider, Majnemer, & Darsaklis, 2010)

Evidence specific to VR use in pediatric ABI PT is minimal. The use of a rehabilitation-specific video-capture VR system (the Interactive Rehabilitation Exercise System [IREX]) was explored in children with ABI, with the finding that performance on the VR tasks was correlated with performance on measures of attention and self-care, and that children enjoyed the VR experience (Bart, Agam, Weiss, & Kizony, 2011). Although the Wii system is being integrated into PT interventions for children with ABI at many centres, evidence is not available to inform its use nor to understand how VR may influence therapist application of MLS within their interventions.

Statement of the problem

The fields of motor learning and neuroplasticity present theoretical and empirical knowledge to inform physiotherapist selection of MLS within interventions for children with ABI. These interventions increasingly incorporate Nintendo's Wii VR video games.

Identifying the active ingredients of VR interventions will demonstrate the links between VR and motor learning and explore why VR use may influence MLS application. Indeed, describing therapist use of MLS in both usual and VR-based therapy is required in order to explore the relationship between MLS application and intervention outcomes, which will inform research and clinical practice. As a first step, little is known about how therapists promote motor learning in usual or VR-based therapy. A valid and reliable measurement instrument is required to study MLS use in usual and VR-based PT interventions.

Summary of study objectives

The objective of the scoping review (Chapter Two) is to explore the relationship between VR and motor learning by identifying the potential active ingredients of VR interventions that are used to improve motor outcomes in children and youth with neuromotor impairments. The objectives of the first study are to create and evaluate an instrument to document the use of MLS within PT interventions for children with ABI, using a process of validity (Chapter Three) and inter-rater reliability (Chapter Four) investigations. In particular, the reliability investigation built upon existing reliability data in a sample of children with ABI (Kamath et al., in press) to compare psychometric properties of the instrument when used to rate 'usual' versus VR-based PT interventions. Although this was not a defined objective, a clinical decision-making model and the definition of 'motor learning strategy' were products of the MLSRI development process (Chapter Three). To complement the quantitative measure, the objective of the second study (Chapter Five) was to explore these physiotherapists' descriptions of their usual and VR-based interventions to promote learning and/or relearning of motor skills in children and youth with ABI. Overall, the studies in this dissertation seek to explore the relevance of motor learning theory to pediatric VR interventions and to describe from both qualitative and quantitative perspectives the use of MLS within usual and VR-based PT interventions for children with ABI.

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Chapter Two

Title of paper: Defining the active ingredients of interactive computer play interventions for children with neuromotor impairments: a scoping review

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Abstract

Rehabilitation researchers who investigate complex interventions are challenged to describe the "active ingredients" of their interventions: the reason(s) why a treatment is expected to be effective. Interactive Computer Play (ICP) is an emerging complex intervention in rehabilitation practice and research. The purpose of this scoping review is to identify the active ingredients of ICP interventions that are designed to improve motor outcomes in children with neuromotor impairments. Eleven potential active ingredients were identified with the following foci: ICP system or game properties; intervention effects on the user; and therapist roles. However, few studies explicitly evaluate the impact of particular ingredients on outcomes. Identification of active ingredients in ICP interventions can inform trial design and clinical decision-making. Research and clinical practice will benefit from studies that utilize a framework such as motor learning theory to guide hypotheses and measurement of the active ingredients of complex interventions.

1. Introduction

Rehabilitation researchers are encouraged to explicitly describe the content of the complex interventions they investigate and utilize in clinical practice (Dejong, Horn, Gassaway, Slavin, & Dijkers, 2004; Whyte & Hart, 2003). Complex interventions involve a number of interacting components, allow for flexibility or individualization of implementation, lead to a variety of outcomes, and involve variations in the difficulty and types of behaviors of intervention administrators and recipients (Craig et al., 2008). When the content of complex interventions is not detailed, these interventions are difficult for clinicians to replicate (Whyte & Hart, 2003). The Medical Research Council (MRC) suggests that researchers begin to detail, develop and evaluate a complex intervention by defining the theoretical mechanisms by which the intervention may cause change (Craig et al., 2008). Complex interventions may involve any number of such ‘active ingredients', defined as the “reason(s) why a treatment is expected to be effective.” (Whyte & Hart, 2003, p.641). Active ingredients may include specific treatment parameters such as dosage or intensity, or more general factors such as therapist-client interaction (Whyte & Hart, 2003). Describing and measuring these active ingredients may benefit research and clinical practice by facilitating an understanding of ‘how' and ‘why' interventions are effective.

New rehabilitation interventions are often evaluated in research and incorporated into practice without a clear understanding of their active ingredients. In pediatric rehabilitation, one such intervention is the use of interactive computer play (ICP), which is "any kind of computer game or virtual reality technique where the child can interact and play with virtual objects in a computer-generated environment." (Sandlund, McDonough, & Hager-Ross, 2009 p.173). Many ICP systems have been developed specifically for use in rehabilitation research to improve motor outcomes in children who have developmental or acquired neuromotor impairments. For example, the Interactive Rehabilitation Exercise System (IREX)[2] utilizes a motion-capture system to embed the user's image within a virtual environment where they can interact with virtual objects (Reid & Campbell, 2006). Recent, commercially-available computer and video-gaming systems such as the Nintendo Wii[3] have made ICP accessible and relevant to clinical practice.

Research in this field is in its infancy and much of what is known about the utility of ICP is derived from feasibility, case study, single-subject or pilot randomized control trial (RCT) designs which focus on establishing efficacy in improving short-term motor outcomes (Sandlund et al., 2009). Reviews of the existing literature are positive about the promise of ICP in these areas , but issues with the methodological quality of the evidence limit the ability to make conclusions and point to the need for on-going research with more stringent designs to explore whether improvements during ICP interventions translate to functional skills (Parsons, Rizzo, Rogers, & York, 2009; Sandlund et al., 2009; Snider, Majnemer, & Darsaklis, 2010). A quick glance at the rationale given by researchers for the likely effectiveness of ICP reveals common acceptance of the fact that these interventions provide feedback over and above what is available in the real world and may motivate children to increase practice duration or intensity. However, whether or

[2] Vivid Group, Inc. 317 Adelaide St W., Suite 903, Toronto ON, M5V 1P9, Canada
[3] Nintendo of Canada Ltd. Suite 110, 13480 Crestwood Pl, Richmond, BC , V6V2J9

not these or any other attributes of ICP could be considered to be active ingredients has not been explored.. The purpose of this scoping review is to identify the potential active ingredients of ICP interventions that are used to improve motor outcomes in children and youth with neuromotor impairments.

2. Method

Scoping reviews (or scoping studies) are a methodology used in health research to describe the breadth and depth of a field of research and to analyze and interpret the findings of the studies that are reviewed (Levac, Colquhoun, & O'Brien, 2010). Scoping reviews include research from a variety of sources but do not typically assess the quality of the included studies; as such, scoping research questions do not address the evidence for a particular intervention but instead generate an output or product that is linked to the purpose of the review (Levac et al., 2010). Levac and colleagues (2010) have provided recommendations to clarify and enhance the original six-stage methodological framework for scoping reviews that was proposed by Arksey & O'Malley in 2005. The stages include 1) identifying the research question, 2) searching for relevant studies, 3) selecting studies, 4) charting the data, 5) collating, summarizing, and reporting the results, and 6) consulting with stakeholders to inform or validate study findings. The current study follows the original framework and the updated recommendations, with the exception of the consultation process. In accordance with these recommendations, a research question and purpose were clearly identified in order to guide the scope of the search strategy. The research question guiding this study was: *What are the potential active ingredients of ICP interventions when used to promote motor outcomes in children and youth with* *neuromotor impairments?* In articulating the purpose of undertaking a scoping review, Levac et al. (2010) suggest that "researchers consider the rationale for why they should summarize the activity in a field and the implications that this will have on research, practice, or policy" (p. 5) as well as the "content and format of the intended outcome" (p.5). Describing the active ingredients of ICP interventions will inform future research and support decisions about their use by rehabilitation clinicians. The authors' envisioned the output of this scoping review as a list of active ingredients, including their frequency and description, as well as a discussion of their relevance to ICP research and practice.

2.1 Search strategy

Scholarly and grey literature was searched using the electronic databases MEDLINE, CINAHL, AMED, EMBASE, PubMed, PsychINFO, PEDro, and Web of Science for papers published between January 1995 and August 2010. Keywords used in various combinations included: child*, pediatrics, virtual reality, virtual reality therap*, computer simulation, virtual therap*, computer assisted therap*, paediatric interaction therap*, video game*, computer game*, user computer interface, visual environment, reality therap*, interactive computer play, motor outcome, motor improvement, play, function, rehabilitation, therap*, physical therap*, and occupational therap*. Reference lists of key articles and conference proceedings were hand-searched. Intervention studies (of any length) describing the use of ICP to improve motor outcomes in children and youth with neuromotor conditions were included for review. For the purpose of this review, "neuromotor conditions" were defined as any developmental or acquired impairments affecting the sensorimotor system. Any articles meeting this criteria were included in the review. These conditions included cerebral palsy, acquired brain injury, developmental coordination disorder, attention deficit hyperactivity disorder, and brachial plexus injury. Motor outcomes were differentiated from other outcomes in the ICP literature, such as improving spatial/navigational, cognitive or behavioural skills. Review articles and studies that solely used ICP with typically developing children were excluded.

2.2 Analysis

Data were extracted from the studies using a charting framework (Arksey & O'Malley, 2005) developed collaboratively by the authors, that collected date of publication, authors, purpose, methodology, description of ICP intervention, length of intervention, outcomes investigated, and potential active ingredients. Two authors (DL and LR) extracted data from five studies and then met to discuss whether the framework was consistent with the study purpose and research question (Levac et al., 2010). Each author then independently extracted data from the remainder of the studies.

The authors met on several occasions to undertake a thematic analysis process for the extracted data using a descriptive analytical method. As per Levac et al.'s (2010) recommendations, the thematic analysis was akin to qualitative content analysis to synthesize the identified potential active ingredients. The authors first determined that active ingredients could be identified on two distinct levels:

Level 1: Potential active ingredients were explicitly described by the researchers of the reviewed study, who linked the proposed active ingredient(s) to at least one study outcome.

Level 2: In contrast, Level 2 potential active ingredients were not explicitly linked by researchers to outcomes and were instead identified as potential active ingredients by the authors of this scoping review. This identification took two forms: In Level 2a, the potential active ingredients were identified from a description of the specific ICP being evaluated in the study. In Level 2b, the potential active ingredients were derived from general statements made by researchers about features or attributes of ICP interventions more generally.

Beginning with Level I, the authors initially compiled a list of potential active ingredients. Disagreements between authors about potential active ingredients were resolved through discussion and active ingredients were listed using terms from the ICP intervention studies. As data were reviewed, new active ingredients were identified or combined with existing active ingredients. Active ingredients where more than one possible mechanism of treatment efficacy was outlined were further categorized. The list of active ingredients was reviewed for similarities and redundancies and a final list was compiled. This process was repeated for Levels 2a and 2b. Lists of active ingredients generated from each level of analysis were compared to identify commonalities and differences. Finally, active ingredients were classified into three categories.

3. Results

The search strategy resulted in the identification of 23 studies, one of which was excluded as it did not involve children with neuromotor conditions. The twenty-two studies included in the final analysis are identified by an asterisk within the reference list. The ICP interventions investigated in the included studies, along with the frequency of studies reporting the interventions, their study designs, and populations are listed in Table 1. Table 2 captures the diversity of outcomes measured within the reviewed studies, including whether the outcomes were measured in the context of the ICP task or in the context of functional activity, as well as other secondary outcomes unrelated to motor skills.

<< insert Tables 1 and 2 here>>

Numerical Analysis

Table 3 outlines the active ingredients identified within studies at each level, and includes the frequency of studies describing each ingredient. Nine active ingredients were initially identified at Level 1. The active ingredient ‘motivation’ was further categorized as several possible mechanisms hypothesized as leading to motivation were described. Six of the active ingredients, as well as four of the hypothesized mechanisms for motivation, were described within studies at Level 2a. One active ingredient was expanded, one further mechanism to encourage motivation was identified and one new active ingredient was added. In Level 2b, six of the active ingredients that had already been identified and 4 mechanisms for motivation were found: one new active ingredient was also identified. In total, 11 active ingredients were described across the levels of analysis.

<< insert Table 3 here>>

Descriptive thematic analysis

Active ingredients were categorized according to whether they related to properties of the ICP system or game, effect of the intervention on the user, or role of the therapist in the intervention.

<u>Level 1: Potential active ingredients linked by researchers to outcomes</u>

ICP system or game properties:

1. *Opportunities for practice*: ICP interventions provide increased duration, intensity and/or frequency of practice.(Bartscherer & Dole, 2005; Deutsch, Borbely, Filler, Huhn, Guarrera-Bowlby, 2008; Huber et al., 2008 ; Huber et al., 2010; Reid, 2002; Reid & Campbell, 2006; Wille et al., 2009; You et al., 2005).
2. *Task specificity*: The tasks or movements trained within the ICP intervention are similar to real-world tasks or movements (Chen et al., 2007; Deutsch et al., 2008; Eliasson, Rosblad, & HagerRoss, 2003; Krichevets, Sirotkina, Yevsevicheva, & Zeldin, 1995; Shaffer et al., 2001; You et al., 2005).
3. *Flexibility to individualize treatment parameters*: The ICP intervention allows for tailoring of the following parameters to the user's needs: the amount and extent of visual and/or auditory feedback, and the duration and/or frequency of game or task trials.(Chen et al., 2007; Deutsch et al., 2008; M. Huber et al., 2010; Krichevets et al., 1995; Qiu et al., 2009; Reid, 2002).

4. *Feedback*: The visual and/or auditory feedback within the ICP intervention provides information about task performance or results (Deutsch et al., 2008; Huber et al., 2010).
5. *Social play equalization*: The ICP intervention equalizes opportunities for children with neuromotor impairment (cerebral palsy) by providing social interaction, acceptance, and barrier-free inclusion in play situations (Reid & Campbell, 2006).

Effect on the user:

6. *Neuroplastic changes*: Practice during the ICP intervention was described as leading to an improved ability of the brain to organize trained movements (Eliasson et al., 2003); training of the 'central clock mechanism' in the central nervous system (Bartscherer & Dole, 2005); establishment of new neural pathways in the brain and increased cortical activation (Golomb et al., 2010; You et al., 2005); and activation of the mirror neuron or 'learning by imitation' system (You et al., 2005).
7. *Problem-solving*: ICP interventions promote user problem-solving through task-driven training (Deutsch et al., 2008), game unpredictability and provision of obstacles (Eliasson et al., 2003), and repetitive practice and augmented feedback (Chen et al., 2007).
8. *Motivation:* ICP interventions motivate children to participate. Several specific mechanisms leading to motivation were identified, including:

- child control over game or task selection (Chen et al., 2007; Deutsch et al., 2008)
- competition against another player or presence of a virtual opponent (Deutsch et al., 2008; Koenig et al., 2008; Wille et al., 2009)
- the challenging variety of game options and environments (Bartscherer & Dole, 2005; Pyk et al., 2008; Qiu et al., 2009; Wille et al., 2009)
- the feedback provided by the ICP (Shaffer et al., 2001; Wille et al., 2009)
- remote monitoring of a home ICP intervention by a therapist (Huber et al., 2010)
- individual attention provided during the ICP intervention (Bartscherer & Dole, 2005).

Regardless of the mechanism leading to motivation, study authors suggested that child motivation was a primary reason that treatment outcomes were achieved.

Therapist roles

9. *Role of a support person*: During the ICP intervention, support from one-on-one training (Shaffer et al., 2001), parental involvement and enthusiasm (Bartscherer & Dole, 2005), and enhanced ability of the therapist to provide verbal feedback (Brutsch et al., 2010) may have contributed to outcomes.

Level 2a: Potential active ingredients derived from a description of the ICP (not explicitly linked by study researchers to outcomes)

Eliasson et al.(2003) suggested that child motivation increased the amount of practice within their study, but did not link this active ingredient to measured outcomes.

We identified this as a potential new mechanism related to the active ingredient 'motivation'. The previously identified active ingredient 'role of support person' was further expanded to elaborate on the therapist's role. Study authors described the therapist as providing expert supervision, (Wille et al., 2009), manual assistance or guidance (Bartscherer & Dole, 2005; Chen et al., 2007), adding resistive force to increase the challenge of the intervention (You et al., 2005), organizing the practice structure of the intervention (You et al., 2005), and providing rewards and encouragement to the child (Krichevets et al., 1995; You et al., 2005). Though not explicitly linked by the study authors to intervention effectiveness, all of these roles could potentially have an impact on study outcomes.

A new active ingredient 'characteristics of the ICP system/game' was identified within the ICP system/game properties category. In Level 1, some aspects of the ICP system or games were identified as mechanisms contributing to user motivation. In this analysis level, properties of the ICP systems or games were viewed by the authors of this scoping review as potential reasons for treatment effectiveness and included the safety of the practice environment (Deutsch et al., 2008), choice of gaming scenarios with a variety of challenge levels (Deutsch et al., 2008; Eliasson et al., 2003; Koenig et al., 2008; Qiu et al., 2009; Wille et al., 2009), the ability of the ICP robot to initiate and assist movement(Qiu et al., 2009), the ability of the avatar to complete a movement onscreen even when subjects did not complete the movement themselves (Golomb et al., 2010); the resistive force provided by the glove used in the ICP intervention (Pyk et al., 2008); the engaging nature of the ICP system (Pyk et al., 2008), having a fun and engaging goal to work towards (Bryanton et al., 2006; Li, Lam-Damji, Chau, & Fehlings, 2009), and undertaking the ICP in the home environment (Huber et al., 2010).

Level 2b: Potential active ingredients derived from a description of features of ICP interventions generally (not explicitly linked by study researchers to outcomes)

Only one new active ingredient, 'comparisons to real-world', was identified within the ICP system/game properties category. That the ICP could provide greater control over therapy as compared to interventions involving real world tasks,(Deutsch et al., 2008) or provide training with ecological validity in terms of similarity to real world tasks (Chen et al., 2007; Deutsch et al., 2008; Wille et al., 2009) was mentioned by several authors as a component of their rationale for using ICP. This attribute is a potential element that could contribute to outcome effectiveness.

4. Discussion

Whyte et al. (2009) advocate a systematic and phased approach to rehabilitation research whereby the mechanisms of treatment effects are described, defined, and examined. This scoping review aimed to identify the potential active ingredients of ICP interventions when used to improve motor outcomes in pediatric rehabilitation. In accordance with the recommendations of Levac et al. (2010), implications arising from the results of this scoping review (in this case, the list of potential active ingredients) will be discussed within their broader context.

In the Level 1 analysis, nine active ingredients were described by researchers as potential reasons why their ICP interventions were effective. However, only the active ingredient 'neuroplasticity' was specifically measured within a study as an outcome (using functional magnetic resonance imaging) (Chen et al., 2007; Golomb et al., 2010). The remaining active ingredients appear to be at a hypothetical stage and will require research evidence to substantiate their proposed effect on outcomes. It will be challenging to measure many of these proposed active ingredients. Measuring practice opportunities by duration or frequency of trial repetitions, for example, may be more straightforward; however, capturing the effect of therapist roles or behaviors during intervention sessions will require more complex study designs. Despite this challenge, measurement is the only way to evaluate hypothesized mechanisms of action. Several studies examined at this level measured some aspects of motivation, enjoyment or satisfaction (see Table 2) but did not relate motivation to intervention effectiveness. Evaluation of the hypothesized mechanisms along with discussion of these proposed mechanisms within study reports are needed.

The Level 2a analysis expanded the "role of a support person' as a potential active ingredient. The depth of description of therapist roles varied across the studies; however, none linked the type of therapist role to intervention effectiveness. The interactive nature of most rehabilitation interventions suggests that therapist behavior and characteristics are potential mechanisms for treatment effectiveness (Whyte & Hart, 2003). Although ICP systems involve hardware and software, interventions still require therapist decision-making about treatment parameters and progression through different levels of the game or task. These and other potential therapist roles require more exploration as potential active ingredients. An in-depth understanding of the therapist's role can help to inform the integration of ICP within mainstream clinical practice.

The Level 2b analysis identified the attributes or properties of ICP interventions generally that could potentially contribute to intervention effectiveness. Potential active ingredients were identified at this level, suggesting that researchers are considering the rationale by which ICP may promote outcomes. Yet none use this rationale to frame their study design, analysis or discussion of findings. ICP intervention research is quite novel and is not often grounded within a clear theoretical framework. Whyte & Hart (2003) suggest that employing a theoretical framework to examine active ingredients facilitates the eventual testing of hypotheses that may advance or refute the proposed theories. Motor learning theory, the underpinnings of many interventions for children with neuromotor impairments, may be one relevant framework for identifying active ingredients within ICP interventions. Motor learning is defined as the relatively permanent changes in motor skills, achieved with practice or experience, which can be retained, transferred and/or generalized to new learning situations (Schmidt & Lee, 2005). Indeed, many of the active ingredients identified from this scoping review, including: 1) opportunities for practice, 2) task specificity, 3) feedback, 4) problem-solving, 5) motivation, and 6) comparisons to real world settings, can be considered key elements of motor learning theory as it is applied to rehabilitation interventions. Motor learning theory may therefore be a relevant theoretical framework in which to base ICP research, as the goal of ICP interventions should be to promote children's ability to use the skills trained within the ICP in real life activities. However, the extent to which the improvements in ICP interventions actual transfer to real life situations is unclear. Studies that are theoretically-driven would be more likely to point to associations between active ingredients and motor learning outcomes such as motor skill retention, transfer, and generalization. Alternative theoretical frameworks that would provide direction for measurement of outcomes related to motivation and/or therapist roles could also be explored within ICP intervention studies.

4.1 Implications for research and practice

The list of active ingredients identified in this paper from the existing ICP intervention literature can serve as a starting point for researchers to consider when designing future trials. A consultation process in which leading researchers in the field are invited to comment on the identified active ingredients may be a useful next step. These ingredients can provide an impetus for discussion about these important concepts and, with evaluation, can inform trials that seek to compare the effectiveness of ICP interventions with other interventions.

The literature in the area of ICP interventions is in its infancy. At this early stage, researchers are most interested in investigating whether or not ICP works and have not yet begun to systematically measure *why* it works. Complex interventions involve a number of interacting components, so it is important to begin to describe and evaluate hypothesized active ingredients in order to better describe interventions, and to examine their effectiveness (Whyte & Hart, 2003). Aligning with the recommendations of Craig and colleagues (2008), we propose a greater emphasis on the use of theoretical frameworks within ICP study designs to facilitate hypotheses relating to the measurement of active ingredients. More specific description of the ICP intervention itself, including the therapist's role (as appropriate), is also needed. Identifying the active ingredients that contribute to outcomes will allow researchers to more confidently assess the effectiveness of their intervention, propose why their ICP system is more effective than others, support informed decision-making about ICP, and allow clinicians to understand the parameters that could be varied for implementation in clinical practice.

4.2 Limitations

The analysis in this scoping review is based upon the authors' interpretation of active ingredients according to Whyte & Hart's (2003) definition, and may not reflect alternative definitions of this construct. The research question explored the reasons put forward by researchers as to the effectiveness of their interventions. Since scoping reviews do not evaluate the quality of evidence, we did not judge whether researchers' statements about intervention effectiveness were supported by their methodologies. The review did not group findings by type of ICP intervention: this could be a subsequent step following substantiation of active ingredients through research. Finally, both rehabilitation-specific and commercially-available ICP systems are under continual development and evaluation, which suggests the need to revisit these findings with the introduction of new systems into practice.

5. Conclusion

ICP use within pediatric rehabilitation will continue to expand as new systems are developed and become accessible within mainstream clinical practice. As a complement to existing reviews, this paper describes the content of complex ICP interventions by identifying active ingredients that might explain why ICP interventions are effective in improving motor outcomes. Although eleven potential active ingredients were identified, few have been evaluated in terms of their effect on outcomes, and they remain hypothetical at this stage. The early stage of the literature in this field is the ideal time for researchers to develop and evaluate theoretical understandings of the mechanisms by which interventions might lead to change. Motor learning theory is proposed as one framework that could be used to guide theoretically-driven studies of ICP interventions.

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*The twenty-two studies included in the final analysis are identified by an asterisk within the reference list

Table 1 – ***Description of ICP Interventions, Frequency of Studies Reporting Interventions, Study Designs, and Study Populations***

Type of ICP intervention	**Brief description**	**Number of studies reporting the ICP intervention**	**Study design**	**Study population and age range**
Computer game	These include commercial and custom-made mouse-controlled games (Eliasson et al., 2003) and a computer game with 'specially devised controls' (Krichevets et al., 1995).	2	Cross-over design; case study	Children born prematurely with impaired coordination; adolescent with Erb's Palsy; ages 6 – 14 years
Interactive metronome	This is a computerized intervention with hand and foot triggers and headphones in which the goal is to activate the trigger in time with the reference beat of the metronome (Bartscherer & Dole, 2005; Cosper et al., 2009; Shaffer et al., 2001).	3	Case study; pre-post design with 2 control groups; pre-post design with single group	Child with attentional issues and developmental delay, children with attention deficit hyperactivity disorder; children with developmental coordination disorder; ages 6-12 years
Robot-based with virtual reality simulations	The 'Haptic Master'is a 6 degree of freedom force-controlled robot for upper limb rehabilitation using virtual reality (VR) simulations involving moving virtual cursors in 3D space (Qiu et al., 2009). The Lokomat gait trainer is a robot-assisted, treadmill-assisted walking device with 3 virtual environments in which the avatar mimics user movements (Brutsch et al., 2010; Koenig et al., 2008).	3	Feasibility study, single case study, experimental study (single test session)	Children with CP (hemiplegia); Child with CP (spastic diplegia), children with neurological disorders; ages 6-16 years
Motion-capture (commercial and rehabilitation-specific)	The Interactive Rehabilitation Exercise System (IREX) uses motion-capture virtual reality in which user's image is embedded within the virtual environment and interacts with virtual objects through body movements (Bryanton et al., 2006; Chen et al., 2007; Reid, 2002; Reid & Campbell, 2006; Reid, 2002; You et al., 2005). The Sony Eye-Toy[4] uses a camera, television, Sony Playstation 2, and Eyetoy 'Play' software to embed the users image within their usual environment and the user can interact with virtual	7	Pilot randomized controlled trial, case report, single subject research designs (SSRDs), single case studies, feasibility case studies	Children with CP; ages 6-16

[4] Sony of Canada Ltd. 115 Gordon Baker Road Toronto, Ontario M2H 3R6

	objects (Chen et al., 2007; Jannink et al., 2008). Li et al., 2009 also use a chair and video signal control subsystem.			
Motion-capture using hand-held interface or glove (commercial- and rehab-specific)	The Pediatric Interactive Therapy System (PITS) utilizes a computer and data gloves with haptic feedback that allow training of arm, wrist and hand movements within gaming scenarios (Pyk et al., 2008; Wille et al., 2009). Chen et al. (2007) utilize a custom- made hand rehabilitation training system involving a personal computer, tracker, sensor glove, and virtual environment displayed on the monitor. A custom-made five sensor sensing glove that connects to Sony Playstation 3, with Linux operating system, computer keyboard, mouse, and modem/router is described by the following authors: Golomb et al., 2010; Huber et al., 2008; Huber et al., 2010.) The Nintendo Wii uses a remote controller with motion sensors measuring movement that is translated onto the screen (Deutsch et al., 2008).	7	Single case studies, feasibility,SSRDs, single case studies	Children with CP; ages 6-16

Table 2 – *Outcome Classification*

Outcome	Study
Performance on the ICP task	(Bartscherer & Dole, 2005; Brutsch et al., 2010; Eliasson et al., 2003; Koenig et al., 2008; Krichevets et al., 1995; Qiu et al., 2009; Reid, 2002)
Self-efficacy or perception of motor skill performance	(Reid & Campbell, 2006; Reid, 2002)
Motivation, enjoyment, or satisfaction with ICP intervention	(Brutsch et al., 2010; Jannink et al., 2008; Koenig et al., 2008; Li et al., 2009; Qiu et al., 2009; Wille et al., 2009)
Physiological changes (i.e. functional magnetic resonance imaging, bone density)	(Golomb et al., 2010; You et al., 2005)
Motor skill that is:	
a. Trained within ICP	(Bryanton et al., 2006; Chen et al., 2007; Cosper et al., 2009; Deutsch et al., 2008; Eliasson et al., 2003; Golomb et al., 2010; Huber et al., 2010; Qiu et al., 2009; Shaffer et al., 2001)
b. Related to skill trained within ICP and measured in context of functional activity	(Bartscherer & Dole, 2005; Chen et al., 2007; Cosper et al., 2009; Deutsch et al., 2008;Eliasson et al., 2003; Golomb et al., 2010; Huber et al., 2008; Huber et al., 2010; Jannink et al., 2008; Krichevets et al., 1995; Pyk et al., 2008; Qiu et al., 2009; Reid, 2002; Reid & Campbell, 2006; Shaffer et al., 2001; You et al., 2005)
c. Measured subsequent to intervention (retention)	(Deutsch et al., 2008; Eliasson et al., 2003)

Table 3 – *Potential Active Ingredients Identified in Studies Reviewed For Each Level of Analysis*

Active ingredients	**Level 1**			**Level 2a**			**Level 2b**		
	Identified: yes or no	# of studies	Studies	Identified: yes or no	# of studies	Studies	Identified: yes or no	# of studies	Studies
ICP system or game properties									
Opportunities for practice	Yes	8	(Bartscherer & Dole, 2005; Deutsch et al., 2008; Huber et al.,2008 ; Huber et al., 2010; Reid, 2002; Reid & Campbell, 2006; Wille et al., 2009; You et al., 2005).	Yes	5	(Bartscherer & Dole, 2005; Brutsch et al., 2010; Bryanton et al., 2006; Eliasson et al., 2003; Shaffer et al., 2001)	Yes	6	(Chen et al., 2007; Jannink et al., 2008; Qiu et al., 2009; D. T. Reid, 2002; Wille et al., 2009; You et al., 2005)
Task specificity	Yes	6	(Chen et al., 2007; Deutsch et al., 2008; Eliasson et al., 2003; Krichevets et al., 1995; Shaffer et al., 2001; You et al., 2005).	Yes	3	(Chen et al., 2007; Deutsch et al., 2008; Li et al., 2009)	No	0	N/A
Flexibility to individualize	Yes	6	(Chen et al., 2007; Deutsch et al., 2008; Huber et al., 2010; Krichevets et al., 1995; Qiu et al., 2009; Reid, 2002)	Yes	14	(Brtsch et al., 2010; Bryanton et al., 2006; Chen et al., 2007; Deutsch et al., 2008; Golomb et al., 2010; Huber et al.,2008 ; Jannink et al., 2008; Krichevets et al., 1995; Pyk et al., 2008; Qiu et al., 2009; Reid, 2002; Reid, 2002; Wille et al., 2009; You et al., 2005)	Yes	8	(Chen et al., 2007; M. Huber et al., ; M. Huber et al., 2010; Li et al., 2009; Pyk et al., 2008; Qiu et al., 2009; Wille et al., 2009; You et al., 2005)
Feedback	Yes	2	(Deutsch et al., 2008; Huber et al., 2010)	Yes	18	(Bartscherer & Dole, 2005; Bryanton et al., 2006; Chen et al., 2007; Cosper, Lee, Peters, & Bishop, 2009; Deutsch et al., 2008; Eliasson et al., 2003; Golomb et al., 2010; Huber et al., 2010; Koenig et al., 2008;	Yes	6	(Chen et al., 2007; Cosper et al., 2009; Jannink et al., 2008; Pyk et al., 2008; D. T. Reid, 2002; Wille et al., 2009)

						Krichevets et al., 1995; Pyk et al., 2008; Qiu et al., 2009; Reid, 2002; Reid & Campbell, 2006; Reid, 2002; Shaffer et al., 2001; Wille et al., 2009; You et al., 2005)			
Social play equalization	Yes	1	(Reid & Campbell, 2006)	no	0	N/A	No	0	N/A
Characteristics of ICP system or game	No	0	N/A	Yes	12	(Bryanton et al., 2006; Chen et al., 2007; D Deutsch et al., 2008; Eliasson et al., 2003; Golomb et al., 2010; Huber et al., 2010; Koenig et al., 2008; Li et al., 2009; Pyk et al., 2008; Qiu et al., 2009; Wille et al., 2009; You et al., 2005)	Yes	10	(Brtsch et al., 2010; Bryanton et al., 2006; Chen et al., 2007; Jannink et al., 2008; Li et al., 2009; Pyk et al., 2008; D. T. Reid, 2002; D. Reid & Campbell, 2006; D. T. Reid, 2002; You et al., 2005)
Comparisons to real world	No	0	N/A	no	0	N/A	Yes	3	(Chen et al., 2007; Wille et al., 2009)(Deutsch J.E., Borbely M., Filler J., Huhn K., Guarrera-Bowlby P., 2008)
Effect on the user									
Neuroplastic changes	Yes	4	(Bartscherer & Dole, 2005; Eliasson et al., 2003; Golomb et al., 2010; You et al., 2005)	Yes	1	(Pyk et al., 2008)	Yes	2	(Pyk et al., 2008; Wille et al., 2009)
Problem-solving	Yes	3	(Chen et al., 2007; Deutsch et al., 2008; Eliasson et al., 2003)	No	0	N/A	No	0	N/A
Motivation due to:									
Competition	Yes	4	(Brutsch et al., 2010; Deutsch et al., 2008; Koenig et al., 2008; Wille et al., 2009)	Yes	2	(Brutsch et al., 2010; Reid, 2002)	Yes	1	(Brtsch et al., 2010)
Game features	Yes	3	(Bartscherer & Dole, 2005; Pyk et al., 2008; Qiu et al., 2009; Wille et al.,	Yes	2	(Brutsch et al., 2010; Huber et al., 2010)	Yes	3	(Brtsch et al., 2010; Qiu et al., 2009; Wille et al., 2009)

			2009)						
User selection of tasks	Yes	2	(Chen et al., 2007; Deutsch et al., 2008)	Yes	7	(Eliasson et al., 2003; Golomb et al., 2010; M. Huber et al.,2008; Huber et al., 2010; Reid, 2002; Reid & Campbell, 2006)	No	0	N/A
Feedback	Yes	2	(Shaffer et al., 2001; Wille et al., 2009)	Yes	1	(Krichevets et al., 1995)	Yes	1	(D. T. Reid, 2002)
Remote monitoring	Yes	1	(Huber et al., 2010)	No	0	N/A	No	0	N/A
Individualized attention	Yes	1	(Bartscherer & Dole, 2005)	No	0	N/A	No	0	N/A
No mechanism specified	Yes	1	(Eliasson et al., 2003)	No	0	N/A	No	0	N/A
Motivation leads to more practice	No	0	N/A	Yes	1	(Eliasson et al., 2003)	Yes	4	(Chen et al., 2007; Cosper et al., 2009; Qiu et al., 2009; D. T. Reid, 2002)
Therapist roles									
Role of support person	Yes	3	(Bartscherer & Dole, 2005; Brutsch et al., 2010; Shaffer et al., 2001)	Yes	7	(Bartscherer & Dole, 2005; Chen et al., 2007; Krichevets et al., 1995; Reid, 2002; Shaffer et al., 2001; Wille et al., 2009; You et al., 2005)	No	0	N/A

Chapter Three

Title of paper: Documenting the content of physical therapy for children with acquired brain injury: Development and validation of the Motor Learning Strategy Rating Instrument

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Abstract

Background

A goal of physical therapy (PT) interventions for children and youth with acquired brain injury (ABI) is the learning and relearning of motor skills. Therapists can apply theoretically-derived and evidence-based motor learning strategies (MLS) to structure presentation of the task and organize the environment in ways that may promote effective, transfer-oriented practice. However, little is known about how MLS are employed within PT interventions for children with ABI.

Objective

To develop and validate an observer-rated Motor Learning Strategy Rating Instrument (MLSRI) quantifying the application of MLS within PT interventions for children with ABI.

Design

A multi-stage, iterative item generation and reduction approach.

Methods

An initial list of MLS items was generated through literature review. Seven experts participated in face validation to confirm item comprehensiveness. In a content validation process, 12 physical therapists with pediatric ABI experience responded to a questionnaire evaluating feasibility and importance of items. Six PT sessions with ABI clients were videotaped at a children's rehabilitation centre. The 12 physical therapists participated in a session where they: 1) rated session videos to test the MLSRI; and 2) provided verbal feedback.

Results

Revisions were sequentially made to the MLSRI based on these processes.

Limitations

The MLSRI is scored during videotape observation rather than live rating; this may be onerous in certain settings and influence therapist or child behavior.

Conclusions

Further reliability investigations will determine whether the 33-item MLSRI is useful to document strategy use during intervention, as an evaluation tool in research and a knowledge transfer resource in clinical practice.

Introduction

Acquired brain injuries (ABI) are a leading cause of disability in children and youth,[1-3] resulting in physical impairments, activity limitations and participation restrictions that require rehabilitation.[4-8] Physical therapy (PT) interventions are provided to improve gross motor performance, enhance high level strength, balance and mobility skills, facilitate functioning and adaptation to disability and reintegrate into home, school and community activities.[4, 9] While a variety of PT intervention options exist for this diverse population, a retrospective study has reported that therapeutic exercise, which includes gait training and aerobic capacity conditioning, was the most frequently provided type of intervention in an early rehabilitation setting.[9] Although studies have evaluated the effectiveness of various interventions at different stages of injury.[10-15] there are no guidelines to support choices for physical therapists in the management of children and youth with ABI in any setting.[4, 9, 16-18] In the early stages of recovery, PT interventions are structured to provide critical learning opportunities in order to positively influence cortical mechanisms of neuroplasticity that are known to be affected by post-injury experience and behavior.[19-21] Therefore, it is essential to understand and describe the content and focus of PT interventions in order to identify and explore their efficacious components.[22]

Children and youth with ABI must not only regain lost motor skills but also continue to learn new motor skills throughout their development.[4, 23] Rather than focusing on the temporary improvements in motor performance that may occur during therapy sessions, therapists can strive to promote children's motor learning: relatively permanent changes in motor skills, achieved with practice or experience, which can be retained, transferred and/or generalized to new learning situations.[24] Motor learning variables are grounded in motor learning theories and empirical evidence. They operationalize motor learning by requiring physical therapists to make choices about their frequency, type, duration, intensity or schedule (e.g., organization of practice: whole versus part; random versus blocked, or amount of practice: more versus less). These decisions are informed by therapist consideration of individual client and task-specific factors[25] and by motor learning principles. Motor learning principles are evidence-based statements that inform the manipulation of many motor learning variables in ways that guide the provision of effective, transfer-oriented practice. For example, motor learning principles regarding practice might state that it should be: intensive, meaningful, and involve active participation on the part of the learner;[26] that greater amounts of practice increase learning; that task practice should be variable rather than constant; and, that practice order should be non-repetitive rather than blocked.[24, 27] Since these motor learning principles are supported by evidence derived mainly from adult, non-clinical populations, pediatric therapists must consider their relevance to children and youth with ABI. Motor learning strategies are the result of this decision-making process. They are observable therapeutic actions involving the selection, manipulation and application of a motor learning variable according to client and task specific factors and with consideration of motor learning principles. Figure 1 outlines the relationships among motor learning theories, research and principles, and illustrates the decision-making process involved in selecting particular motor learning strategies (MLS) for use.

INSERT FIGURE 1 HERE

There is experimental evidence that applying MLS in typically developing children[28-30] and in children with cerebral palsy (CP)[31] influences motor learning outcomes. A recent RCT evaluated a 'motor learning coaching' approach involving the use of MLS as compared with a NeuroDevelopmental Therapy (NDT) approach in children with CP.[32] The study found that both groups improved at 3 months post-intervention; but, at 6 months post-intervention, children in Gross Motor Function Classification System (GMFCS) level 2 who had received the motor learning coaching demonstrated significantly greater retention of functional skills and mobility in community environments, while scores in these areas declined in the NDT group. Other intervention approaches that explicitly emphasize selection of MLS, such as constraint-induced movement therapy (CIMT)[33] for children with hemiplegia and Cognitive Orientation to Occupational Performance (CO-OP)[34] as well as Neuromotor Task Training for children with Developmental Coordination Disorder (DCD)[35] have also demonstrated positive outcomes. Changes in patterns of brain activation following motor learning have also been demonstrated through Functional Magnetic Resonance Imaging in children with DCD.[36]

There are few guidelines underlying the application of MLS within general pediatric interventions.[25, 37, 38] Particularly little is known in ABI, where children's cognitive, memory or behavioural impairments may be client factors that influence physical therapist decision-making with respect to the application of MLS.

From the perspective of learning about physical therapists' use of MLS within their interventions, Larin observed pediatric therapists as they provided therapy for children with CP, and documented the use of many recognized MLS within these sessions.[39] In interviews that followed the observational sessions, the therapists demonstrated varying degrees of awareness about MLS, some of which was implied rather than explicit. Zwicker & Harris suggested that therapists may be implicitly applying these strategies, and argued the need for more conscious reflection on their application in practice.[37] A survey of pediatric physical therapists in the United States found that therapists reported requiring more information to support them in the use of a motor learning approach,[40] suggesting that usage of MLS may require additional training.

Existing instruments that measure the application of MLS may have limited clinical applicability for children and youth with ABI. Larin developed the observer-rated Motor Teaching Strategy Coding Instrument to quantify MLS use by physical therapists working with children with CP.[39] While initial validity and reliability investigations were positive, the instrument's focus on analysis of individual activity trials and its rating complexity pose limitations. Hashimoto et al. developed a self-report scale to quantify the content of pediatric PT interventions; however, 'motor learning' is only one of its 76 items.[41] To document the content of Neuromotor Task Training (NTT), Neimeijer et al. developed a taxonomy of verbal actions directed towards improving learning in children with DCD.[42] While it provides a useful classification of MLS, these are specific to the NTT intervention approach.

It is important that measurement of MLS application be relevant to current trends within pediatric rehabilitation, such as use of the commercially-available virtual reality (VR) video games Nintendo Wii and WiiFit. These popular and accessible games appeal to physical therapists because they use motion-sensing technology to detect acceleration and orientation, allowing a child to control games by means of movement and posture.[43] Given that these VR games provide opportunities for consistent repetition of a realistic task with abundant sensory feedback,[44] their use in practice may influence therapist application of MLS.

Ultimately, evidence from empirical studies is needed to guide choice of MLS in clinical settings and to demonstrate the extent to which applying strategies impacts functional outcomes.[25, 37, 39] The purpose of this study was to develop and validate an observer-rated instrument to quantify the extent to which MLS are used during PT interventions for children and youth with ABI. Specifically, the objectives were to generate items, to undertake a face and content validity evaluation process, and to use this feedback to create a final version of the instrument. Given the increasing prevalence of VR video games within pediatric rehabilitation,[45] it was believed to be important to include items specific to use of this technology as well.

Methods

This study used a multi-stage, iterative item generation and reduction approach that resulted in the creation of a series of test versions of the MLRSI (see Figure 2). Ethical approval for the study was received from the [children's rehabilitation centre name and University name] Research Ethics Boards.

INSERT FIGURE 2 HERE

a) Item generation

In order to construct an initial list of items, instrument development began with a literature review of peer-reviewed publications, PT and motor learning textbooks, and from clinical observation of PT intervention sessions for children and youth with ABI. Version 1 of the MLSRI (items and response scales) was prepared for review in a face and content validity evaluation process.

b) Validity testing

A convenience sample of 12 North American experts identified through their publication or academic experience in the fields of motor learning and pediatric rehabilitation was established to evaluate face validity. These individuals were sent a copy of Version 1 and invited to respond in writing to five questions regarding item comprehensiveness. Based upon this feedback, revisions were made to create Version 2. Its content validity work began with a convenience sample of 12 pediatric physical therapists currently working with clients with ABI. They were invited to take part in an on-line questionnaire in which they reviewed Version 2 and commented on the feasibility and importance of each item, using a 6-point agreement-based rating scale. This feedback was reviewed by the study authors, all physical and occupational therapists with expertise in motor learning.

Six PT intervention sessions with three physical therapists and six ABI clients were videotaped by a non-PT research assistant (RA) at a large children's rehabilitation centre. No restrictions or demands were placed on the content of the intervention sessions. The RA endeavored to remain close to the therapist and client during videotaping while not unduly intruding in the session, and attempted to capture a full frontal or side view of the client and therapist throughout the session. The PTs who provided the sessions were blinded to the study's focus on the use of MLS.

The study authors watched the PT session videos and reached a consensus about suggestions for item refinement. The results of this consensus exercise led to Version 3.

Physical therapists who had been invited to respond to the previous on-line questionnaire participated in a session where they rated videos using Version 3 and provided verbal feedback about its content and use. In advance of this meeting, participants had been sent a copy of Version 3. Participant training on MSLRI use was limited to verbal instructions and examples of certain items. They watched two pre-selected 10-minute clips from the videotapes on individual laptops, permitting control over stopping and starting the clip. Raters used version 3 to rate MLS use in each clip. Note-takers recorded the discussion and feedback that followed. Revisions from this process led to Version 4. Using the videotaped intervention sessions, further refinement of this final version took place with five PT student raters working with authors DL and VW to clarify item definitions and examples.

Results

The results that follow sequentially describe the creation of the four versions of the MLSRI, and reflect the iterative process used.

a) Item generation

The literature review and session observation yielded an initial list of 30 items. These were based on a variety of motor learning theoretical perspectives and on the findings of motor learning research with children with disabilities. For example, several items reflect strategies grounded in cognitive motor learning theory, which emphasizes the promotion of active problem-solving and verbalization on the part of the learner [46]. The majority of items reflect the use of a MLS by a physical therapist. However, some also reflect the outcome of strategy application on child behavior (and therefore involve rating the child) or on the session as a whole (and thus involve rating the session). Given that the PT sessions were with children with ABI, there was a need to include at least one item relating to the child's level of attention to therapy tasks. The apparent complexity of rating MLS led to the decision to rate videotaped intervention sessions rather than live sessions.

Items in Version 1 of the MLSRI were worded in sentences (e.g. "Therapist verbalizes goal(s) and/or strategies relating to performance, learning or outcome of the activity"; "Therapist provides hands-on physical guidance and/or touch cues during activity practice" and "The context for learning appears optimal, stimulating and relevant to the child's needs.") At this point, they were not organized into categories. Version 1 used a 7 point Likert scale reflecting the extent to which each item was observed by the rater during the intervention session (i.e., ratings from 'not at all' to 'a very great extent').

b) Face validity: Version 1

Nine of the twelve experts who were invited to participate responded the request for feedback. All had a rehabilitation and motor learning background and were academics/faculty members at North American Universities. Their written responses to each of the five face validity questions posed are summarized below.

1. *Do the items accurately encompass the motor learning strategies that you view as being most relevant to pediatric PT practice?*

All experts indicated that this was the case.

2. *Are we missing any motor learning strategies?*

A number of additional items were proposed, including items related to ensuring an optimal learning environment for the child, ensuring that an activity was functional for the child, rating the frequency of rest periods provided, and rating the provision of intermittent or faded feedback and/or feedback frequency. Another suggestion was to add more variations in practice opportunities, e.g., the use of mental practice and practice in a different setting.

3. *Is the wording of any items unclear to you?*

Several items were considered to be problematic. For example, the original item worded 'The child is encouraged to make errors during practice' was seen to imply that poor performance was a desired outcome. The recommending rewording was 'The child is encouraged to repeat activities and informed that errors are part of learning'. Another suggestion was to provide indicators that would help to clarify some of the items. For example, in the item 'The therapist demonstrates an organized approach to the therapy session', the instrument should provide indicators for operationalizing the term 'organized'. Finally, it was felt that the instrument needed to specifically define what was meant by an 'activity' and to provide examples to assist raters in determining what they should and should not be rating.

4. Do you believe that a rating form such as this could feasibly be used by a trained physical therapist assessor to rate the use of motor learning strategies within therapy interventions?

The experts unanimously agreed that it could be, and no other comments were made.

5. Is there any other feedback that you wish to provide?

Experts suggested clarifying the content of items in which too many components were involved, making it difficult for raters to score the item if just one component was observed but not another (for example, 'Feedback is directive, does not involve open-ended questions, encourages problem-solving, and requires verbal responses from the child'). Experts suggested aesthetic changes to instrument lay-out.

Version 2 was created from this feedback. While no items were deleted at this stage, wording changes to clarify and simplify items and enhance visual presentation were undertaken and two items reflecting experts' ideas were added. The suggestion to include whether practice occurred in a variety of settings was merged within an existing item ('the therapist incorporates available environmental resources (settings, people or objects) within the session'). However, several other suggestions were not implemented, including those related to adding an item to rate feedback frequency and whether this was intermittent or faded. This was determined to be unrealistic to measure in a session that included a multitude of activities in which the therapist may provide different feedback frequencies throughout. Rating whether practice was massed or distributed was also felt to be unrealistic, as rest periods in this population are often dictated by factors such as fatigue that do not relate to therapist decision-making about use of this MLS. Rating whether or not an optimal learning environment was provided was felt to be too subjective. Finally, rating the functionality of the activity was not included because it was too difficult to judge function given that independent raters would know very little about a child in a videotape.

b) Content validity: Version 2

Eight of the 12 invited physical therapists from Southwestern Ontario completed the online questionnaire evaluating Version 2 of the MLSRI. All had experience working with children and youth with ABI. Therapists were instructed to consider an 'activity' as having an observable beginning and ending. All respondents either 'strongly agree' or 'agree' with the feasibility and importance of each of the 32 items in Version 2, with the exception of four items in which respondents disagreed for 'feasibility' and six items in which respondents disagreed for 'importance'. For 'feasibility', these items were: 'the extent to which purposeful activities were practiced', 'the session involves practice of more than one activity', 'components of the activity were practiced individually', and 'the activity was practiced as a whole'. Respondents commented that 'purposeful' was too subjective; the authors agreed and the item was removed. The second item was felt to be redundant given that an intervention session would most likely include more than one activity; this item was removed. The ‘individual practice ’ and ‘whole practice’ items were reworded to improve clarity. For ‘importance’, the disagreement items were: ‘the provision of negative feedback’, ‘the extent to which practice was challenging’, ‘the extent to which the child was motivated and engaged’, ‘the extent to which the child required redirection’, ‘the extent to which the child was focused or attentive’, and ‘the extent to which the therapist demonstrates an organized approach to the session’. Based on consultation among the study authors, the negative feedback, challenging, motivated/engaged and redirection items were reworded, and the focused/attentive and organized approach items were removed due to perceived subjectivity. Additional feedback from respondents was that the instrument was lengthy and that it should be broken down into sections to increase ease of use. Feedback from the process led to Version 3, in which items were further simplified by reducing word content and then grouped into seven categories such as ‘instructions/feedback’ and ‘activity practice’ based on similar motor learning variables.

Subsequently, Version 3 was trialed over a series of three group sessions with all authors of the paper watched selected videotapes and rated them using the revised MLRSI This process led to changing the response scale from 7 to 5 points as the ‘very small’ and ‘fairly great’ extent were felt to be too specific and too difficult to accurately judge. An ‘unable to rate’ option was added. The authors also changed the wording from ‘activity’ to ‘task’ as this term was more familiar to physical therapists**.** Three Wii/Wiifit specific items was added at this time such as “The therapist uses the visual or auditory information provided by the Wii/WiiFit within the therapy session”.

The twelve physical therapists attended a session to view two videos and score MLS use according to Version 3. Overall, the participants agreed that the instrument was simple to use but that they would require more training to increase their confidence. The group exercise guided the rewording of items in which there was notable within-child variation in item scores across raters. Clarification and rewording of these items, as well as development of rater training materials for the MLSRI as a whole, was guided by suggestions made by these clinical experts. Given that the instrument is meant to be used to rate the session as a whole, participants suggested that a worksheet (Appendix 1; p.92) be created to allow raters to capture and track their thoughts and observations as they were watching a videotape. By providing a visual space for raters to judge the frequency of strategy observation, this worksheet provides raters with a reference from which to draw when making decisions in instrument rating. This process led to the fourth and final version of the MLSRI ©[e]. It contains 33 MLS grouped in 7 categories. Appendix 2 (p.92) provides a sample of the instrument.

As a final step in the development of rater training materials, four PT students underwent 18 hours of training with the instrument in which detailed explanations and examples of each item were developed and revised through group discussion with DL and VW.

Discussion

The purpose of this study was to describe the development and initial validation process of an instrument that allows observers to measure the use of MLS in PT

[e] ©Levac D, Missiuna C, Wishart L, DeMatteo C, Wright V. The Motor Learning Strategy Rating Instrument. 2010. Hamilton, ON: McMaster University.

interventions for children and youth with ABI. The instrument builds upon the need first addressed by the development of an observational tool by Larin for use evaluating the motor learning content of PT interventions for children with CP.[39] The MLSRI includes a wider variety of MLS than the tool developed by Larin, is geared towards usage with children and youth with ABI, and includes items related to the Wii/WiiFit. Items in the MLSRI are grounded in theory and evidence and represent a variety of motor learning theories. An instrument that is able to quantify the extent of use of MLS by physical therapists is an essential first step in being able to evaluate whether or not strategy use is related to improvement in motor learning outcomes.

The face and content validation process described in this paper suggest that the MLSRI is a valid way to measure the use of MLS within PT interventions. However, these results should be interpreted as subjective determinations given the context of face and content validity evaluations,[47] and point to the need for ongoing validation of this newly developed instrument. Limitations identified with the development process used include the fact that initial item generation was undertaken primarily by one author (DL). As a result, the initial pool of items may have been biased. For example, consideration of the learner's stage of learning and the type of task that is being learned are not components of this instrument, although they are prevalent concepts in the motor learning literature.[24] However, experts did not identify this as an issue during the face validity stage of instrument development, perhaps because the target population (children with ABI) are recognized to be re-learning motor tasks.

The intervention sessions that informed instrument development involved videotapes of three therapists at a single children's rehabilitation centre. It is evident that the practice of these three therapists does not represent all possible PT interventions with this population, and that including a larger number of therapists from several centres might have provided wide set of intervention possibilities from which to base items. However, with the exception of the Wii/WiiFit items, the strategies chosen considered both the literature as well as the practice of these physical therapists.

Although the experts in the face validity phase were based across North America, the physical therapists in the content validity process were all from Southern Ontario. Further validation will be required with a larger and more diverse group of physical therapists working with children and youth with ABI.

While training materials were developed to reduce subjectivity by providing clear definitions and examples of each item, there are inherent challenges to observer rating of another physical therapist's behavior in a videotaped session. These include the rater not being familiar with the goals of the session or with the child's characteristics and the rater bringing his or her own biases and assumptions about how interventions for children and youth with ABI should be structured. The MLSRI was designed to be used during observation of a videotape as opposed to a live rating. This may affect its applicability in settings where videotaping resources are less available, and may also influence the behaviour of the therapist or child being videotaped. However, whether videotaping may affect behavior to a greater extent than the presence of a live rater is unknown.

Future directions for research and clinical implications

The MLSRI is undergoing reliability evaluation, demonstrating excellent total score intra-rater reliability and moderate total score inter-rater reliability, with further development of item definitions and rater training materials currently underway. [48] While there is no 'gold standard' instrument with which to compare the MLSRI for criterion validation, it should be possible to undertake a known-groups construct validation by comparing scores on the MLSRI of sessions from therapists who have participated in specific motor learning knowledge translation/training initiatives versus those who have not, or comparing scores from sessions in which the therapist uses approaches known to differ in their emphasis on MLS (such as an NDT approach).

There is currently little evidence to support the idea that application of any of these strategies by physical therapists, to whatever extent, influences outcomes of motor learning in this population. Therefore, clinical applications of this tool needs to include documenting the use of MLS in PT practice for children and youth with ABI and linking this to children's motor learning outcomes to begin to understand which strategies may be effective. Research can be designed to specifically evaluate these strategies, or a combination of strategies, as an intervention approach.

Finally, it will be important to determine the number of training hours required for skilled use of this instrument, as this will affect clinical and research applicability. The MLSRI could be used as an outcome measure to evaluate change in practice following a knowledge translation initiative designed to educate therapists about use of MLS. It may also prove to be a useful knowledge translation tool to help therapists become more self-reflective about their practice [39].

Conclusion

The MLSRI is a new 33-item observational tool, grounded in empirical literature and refined through an iterative validation process. Face and content validity were demonstrated in this study with respect to use of MLS within PT interventions for children and youth with ABI. In this complex population, little is known about the strategies used within PT interventions, so being able to explore this content from a motor learning perspective will advance practice in this area. Specifically, the ability to measure MLS use during interventions will permit the link between motor learning and outcomes to be systematically evaluated. While the MLSRI has the potential to be useful in research and clinical practice, further validity and reliability investigations are required.

INSERT APPENDICES 1 AND 2 HERE

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Figure 1: The motor learning strategy clinical decision-making process

Figure 1: The motor learning strategy clinical decision-making process

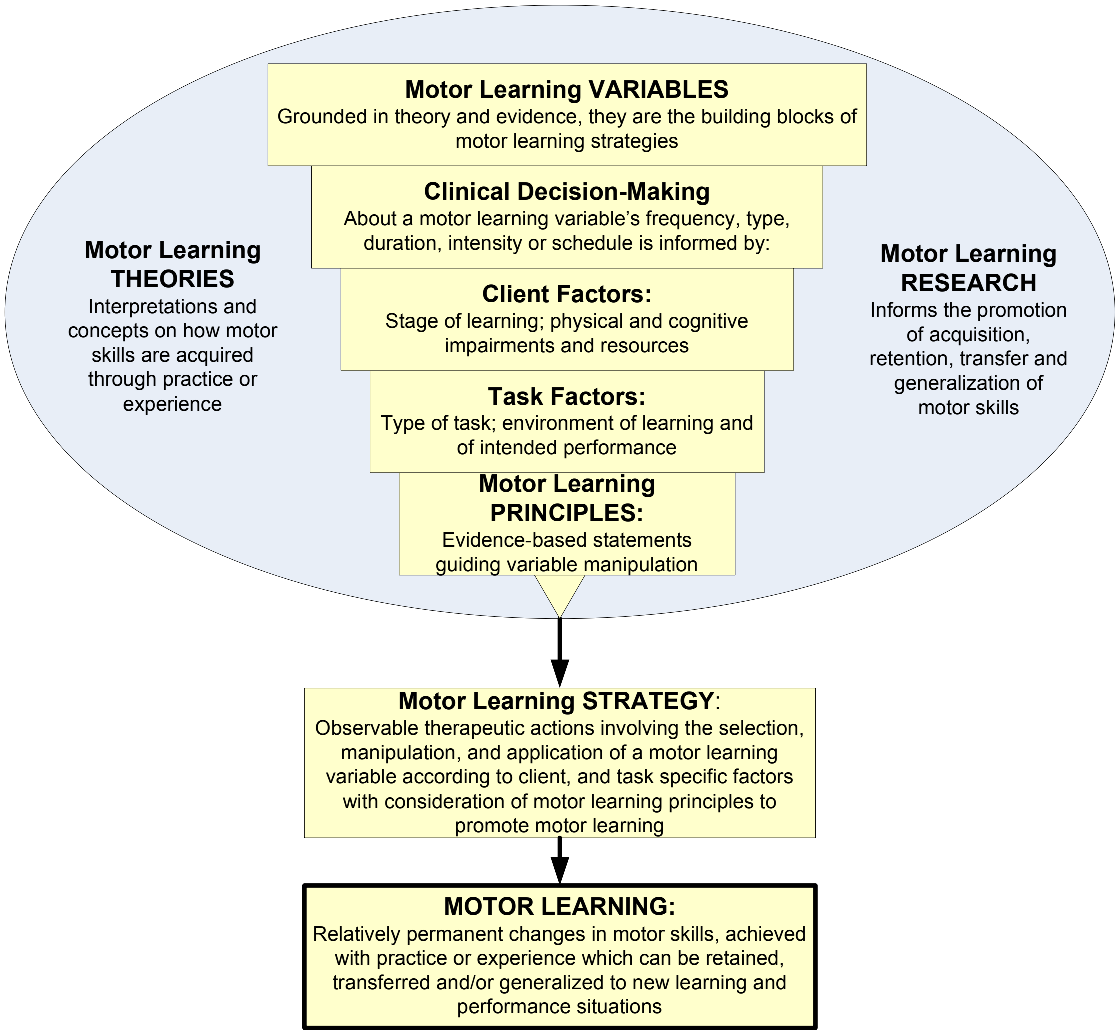
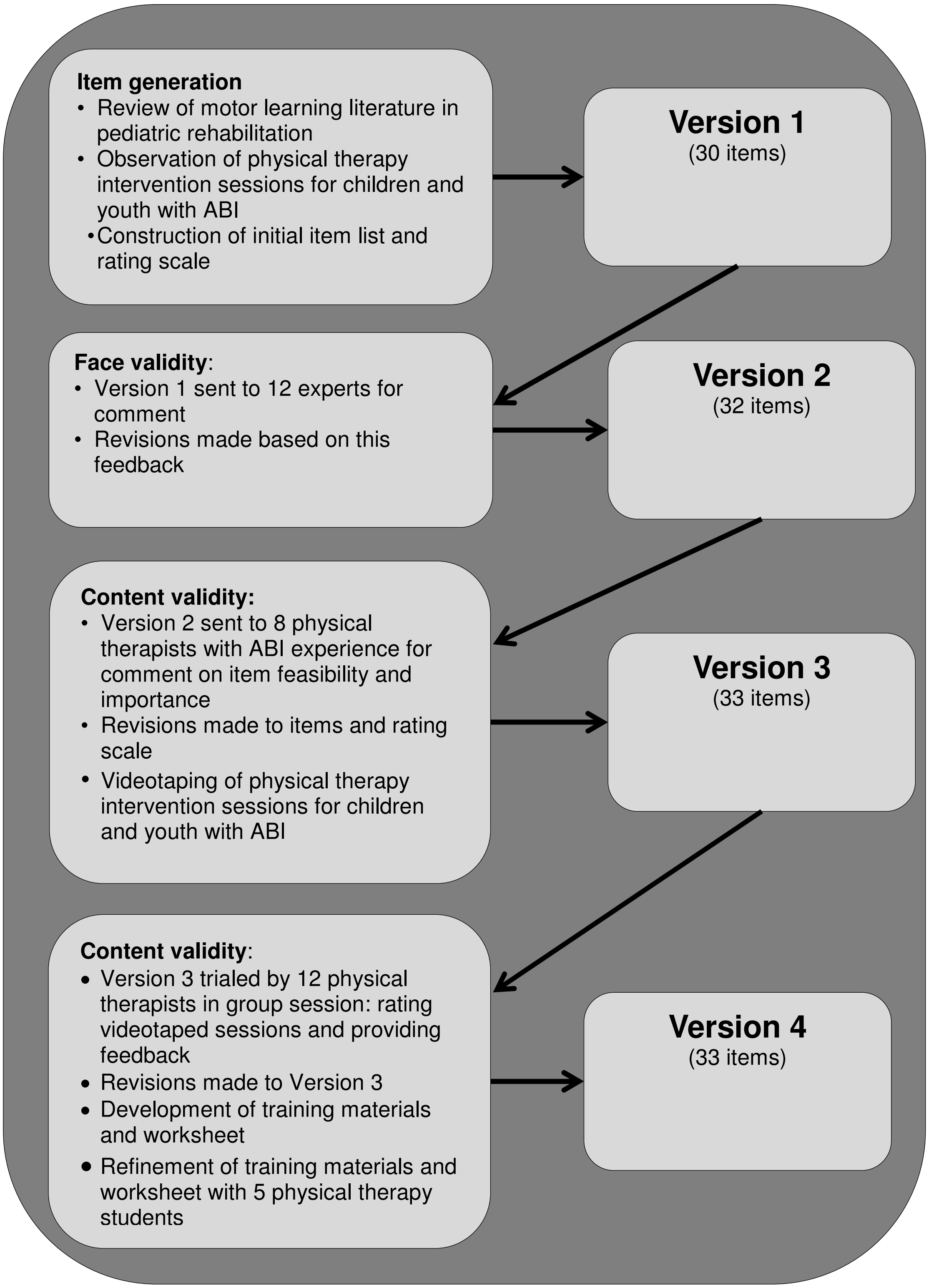


Figure 2: Development and content validation process



Appendix 1: MLSRI Worksheet sample

PRACTICE		
Part	vs	Whole
Same	vs	Varied
Challenging	and/or	Progressive
Mental practice *(specify)*	**WII: CHILD ATTENDS TO INFORMATION**	**WII: THERAPEUTIC INTENT**

Appendix 2: MLSRI Instrument sample

Please rate the extent to which these strategies occur:	**not at all**	**small**	**moderate**	**great**	**very great**	**Unable to rate**
Practice is:						
1. Active	*0*	*1*	*2*	*3*	*4*	*X*
2. Repetitive	*0*	*1*	*2*	*3*	*4*	*X*
3. Whole (rather than part)	*0*	*1*	*2*	*3*	*4*	*X*
4. Variable (rather than constant)	*0*	*1*	*2*	*3*	*4*	*X*
5. Challenging	*0*	*1*	*2*	*3*	*4*	*X*
6. Progressive	*0*	*1*	*2*	*3*	*4*	*X*

Chapter Four

Title of paper: Reliability of the Motor Learning Strategy Rating Instrument within usual and virtual reality-based interventions for children with acquired brain injury

Authors: Danielle Levac, Cheryl Missiuna, Laurie Wishart, Carol DeMatteo, and Virginia Wright

This paper is under review by Pediatric Physical Therapy.

Abstract

Purpose:

The aim of this study is to evaluate and compare the inter-rater reliability of the Motor Learning Strategy Rating Instrument (MLSRI) within usual (i.e. non-virtual reality [VR]) and VR interventions for children with acquired brain injury.

Methods:

Two intervention sessions for each of 11 children (total=22) were videotaped; sessions were provided by 4 different physical therapists. Videotapes were divided into usual and VR components and rated by 2 raters with the MLSRI. A generalizability theory approach was used to determine inter-rater reliability of the MLSRI for usual and for VR interventions in this repeated-measures design.

Results:

Inter-rater reliability for usual interventions was high for the MLSRI total score (g-coefficient 0.81) while it was low for the VR total score (g-coefficient 0.28); MLSRI category g-coefficients varied from 0.35 to 0.65 for usual and from 0.17 to 0.72 for VR interventions.

Conclusions:

Adequate reliability was achieved within ratings of usual interventions. However, issues related to item compatibility with VR interventions, rater familiarity with features of the VR system, and the logistics of videotaped sessions affected reliability of VR intervention rating, suggesting the need to revisit MLSRI validity evaluations and expand rater training in subsequent VR-based investigations.

Introduction

The physical and cognitive impairments arising from an acquired brain injury (ABI) may present a substantial burden for children and youth, leading to long-term functional limitations and participation restrictions.[1] Children with moderate and severe ABI often receive physiotherapy interventions within in-patient rehabilitation to regain gross motor, mobility, and balance skills and support re-integration in home, school and community activities.[2,3] Although studies have evaluated the effectiveness of various interventions at different stages of injury, there are no practice guidelines to support choices for physical therapists in the management of children and youth with ABI in early rehabilitation.[2-5] Given that the learning that occurs within rehabilitation interventions may influence neuroplastic mechanisms of recovery,[6] the ability to describe intervention content is vital to develop, evaluate and replicate effective treatments.

The complex nature of rehabilitation interventions implies that a specific focus be chosen when describing intervention content.[7] While interventions can be based in many theoretical frameworks, motor learning theory is a relevant focus for exploring the content of physiotherapy interventions for children and youth with ABI. This population must not only regain lost motor skills but also learn new motor skills as part of their continuing development.[3,8] Motor learning is defined as the relatively permanent changes in motor skills, achieved with practice or experience, that can be retained, transferred and/or generalized to new learning situations.[9] Rather than simply improving motor performance during therapy sessions, the goal of physiotherapy sessions that are based in motor learning is for clients to retain skills so that they can use them in real-life activities and settings.[10]

Levac, Missiuna, Wishart, DeMatteo, & Wright[11] have described a clinical decision-making process that outlines how therapists can use motor learning strategies in practice (see Figure 1). Motor learning strategies (MLS) are observable therapeutic actions involving the selection, manipulation and application of a motor learning variable according to client and task specific factors and with consideration of motor learning principles. Motor learning variables, based in motor learning theories and empirical evidence, require physical therapists to make choices about their frequency, type, duration, intensity or schedule (e.g., organization of practice: whole versus part; random versus blocked, or amount of practice: more versus less).[11] Examples of MLS include providing verbal feedback about task performance or structuring the order of tasks or activities within the practice session. While some evidence for the method and extent of MLS application exists in other pediatric populations, little is known about how therapists use MLS in their interventions for children and youth with ABI, where children's cognitive, memory or behavioural impairments[12] may be client factors that influence intervention content.

<<insert figure 1 here>>

PT interventions for children with ABI can include new technologies such as the interactive virtual reality (VR) video games Nintendo Wii/WiiFit[f] that are gaining popularity within pediatric rehabilitation.[13] Currently, few reports exist to provide

[f] Nintendo of Canada Ltd. Suite 110, 13480 Crestwood Pl, Richmond, BC , V6V2J9

evidence or direction for therapists interested in integrating this technology within clinical practice. These VR games may have an impact on the extent and manner of therapist use of MLS as compared to usual interventions given their inherent features of providing feedback and opportunities for consistent repetition of tasks.[13,14] Exploring the link with MLS use is an important step in designing and evaluating VR interventions.

In recognition of the need to quantify the use of MLS, our research group used a systematic development process (incorporating face and content validity analysis) to create the Motor Learning Strategy Rating Instrument (MLSRI)[g] ©. This is a 33 item observer-rated scale designed to rate the extent of MLS use within a videotaped physiotherapy intervention session.[11] An initial evaluation of inter- and intra-rater reliability was completed.[15] The MLSRI demonstrated excellent total score intra-rater reliability (Intra-class correlation coefficient [ICC] 0.86 [95% confidence interval (CI): 0.66–0.94)]. However, total score inter-rater reliability was found to be inadequate (ICC 0.50 [95%CI: 0.08–0.78], and we proposed that a key issue may have been lack of consistency between raters' interpretations of item definitions.[15] Further development of item definitions and rater training materials was undertaken, and the revised instrument was used in this study. The instrument has not yet been evaluated for reliability specifically within VR interventions. The purpose of this study is to further evaluate and compare the inter-rater reliability and feasibility of the revised MLSRI between usual and VR interventions.

[g] © Levac, Missiuna, Wishart, DeMatteo, & Wright. (2011) The Motor Learning Strategy Rating Instrument..

Material and Methods

Design

This study used a repeated-measures observational design in which participants received both usual and VR interventions in each of two therapy sessions (see Figure 2). Two sessions per child a minimum of two weeks apart were included to capture potential changes in MLS use at different points in the child's recovery. The extent of MLS use within usual and VR interventions was separately rated in each of these sessions. Ethical approval was received from the McMaster University Research Ethics Board and the ethics board of the Holland Bloorview Kids Rehabilitation Hospital.

<<insert figure 2 here>>

Setting and participants

The study took place in the in-patient brain injury rehabilitation unit at a large children's rehabilitation centre in Toronto, ON. To avoid influencing the content of videotaped intervention sessions, the study focus on use of MLS was not revealed to the therapists during the recruitment and data collection processes. Therapists were informed that the study purpose was to evaluate an instrument measuring frequency and nature of their intervention activities. Physical therapists identified eligible children and youth among their clients and a research assistant (RA) provided more information about the study and obtained informed consent. Inclusion criteria for children and youth were that they be diagnosed with an ABI; ambulatory (independent or with a walking aid); receiving in-patient physiotherapy services; aged 7 to 18 years; and that the VR be a key component of the therapist's existing intervention plan geared towards improving motor skills. Given the inclusion of the VR in their interventions, we anticipated that therapists would not identify children who demonstrated significant cognitive limitations. The only exclusion criterion was a history of seizure(s), as Nintendo lists this as a warning for the use of their product. The physical therapist inclusion criterion was a willingness to be videotaped while delivering interventions. Written informed consent/assent was obtained from physical therapists, children/youth and their parents as appropriate.

Procedures

Demographic information about children and therapists was obtained. For each child participant, two physiotherapy intervention sessions taking place at least two weeks apart were videotaped by the RA. The RA positioned herself so as to optimize the video views and audio capture while avoiding intruding into the session. She attempted to capture full frontal or side views of both child and therapist throughout the session.

Intervention content was not dictated by the study other than the eligibility requirement that the therapists use the VR as a component of their intervention session. All interventions were geared towards improving motor skills. 'Usual' (i.e. non-VR) interventions targeted gait training, strengthening, balance (static or dynamic), endurance, or coordination. Therapists used traditional therapy tools such as a treadmill, bicycle, balance boards, balls and other toys, and provided interventions in a therapy gym, hallway, or stairwell.

For VR interventions, requirements for Wii usage programs and times were not specified. The Wii uses motion-sensing technology to detect acceleration and orientation, allowing the child to control games by means of movement and posture.[13] The Wii remote control uses accelerometers that enable it to detect movements in three dimensions. Miniscule movements of the controller to whole body movements can be used to play the games. An on-screen avatar (a visual representation of the self) mimics movements realistically on screen. Therapists primarily used the Wii sports games and the Wii Fit balance games. A description of the five Wii Sports games can be found in Deutsch et al. (2008). [13] The Wii Fit is a pressure-sensitive balance board in which weight-shifting and changes in body posture control 12 different balance games. VR interventions took place in a small therapy room. Children stood approximately 3 feet from the flat screen television on which the VR was displayed. Therapists often integrated additional therapy equipment such as balance boards and weights into their VR interventions. They chose whether or not to participate in VR game play to provide competition for the child.

The RA transformed usual and VR components of each videotaped session into separate mpeg movie format files to facilitate separate independent rating. Two physiotherapy student raters, who were part of the initial reliability study, had undergone an extensive training and review process (see[15]) to learn to use the MLSRI in usual interventions. Subsequent training was undertaken with the revised item definitions and with VR interventions. These raters independently rated the usual and VR components of the videotapes in a randomized order, with a minimum of two days between ratings of the same child. For the feasibility evaluation, raters recorded the time taken to rate each video and used 10cm visual analogue scales to indicate their confidence and difficulty with rating each session.

Measures

The Motor Learning Strategy Rating Instrument (authors, 2010)

The MLSRI contains 33 items divided into six categories: therapist provision of verbal instructions, feedback or cues (*therapist verbalizations:* 10 items); child verbalizations related to learning (*child verbalizations*: 3 items); organization of practice (*practice:* 6 items), therapist techniques (*guidance:* 3 items), observations about therapist and child behavior in the session as a whole (*conduct:* 6 items), and use of the VR (Wii) (*VR:* 3 items). Table 1 provides examples of items in each category; Appendix 2 (p. 92) provides an example of the instrument lay-out. All items are rated on a five point ordinal scale that quantifies the extent to which (from 'not at all' to 'very great') a specific MLS occurred within the observed treatment session. Higher total and category scores indicate greater extent of MLS use.

The MLSRI also contains two items comprising the category of *carry-over* of practice rated on a categorical scale (yes, no, unable to rate). These items reflect whether the therapist recommends practice of specific tasks outside of therapy time, and whether the therapist provides training to support this practice directly to a caregiver. These items are not included in the total score but are evaluated on their own to indicate the presence or absence of these MLS.

A worksheet is used to track rater impressions while they watch the videotaped session and to document the frequency at which specific MLS are observed (see Appendix 1 [p. 92] for an example of worksheet layout). Immediately following observation of the video, the rater uses the information from the worksheet as a guide to complete the MLSRI.

<<insert Table 1 here>>

Data analysis

Descriptive statistics were calculated for child and therapist demographic data. To standardize the scoring of the MLSRI, total and category scores were converted to percentages. To determine inter-rater reliability of the MLSRI for usual and VR interventions in this repeated-measures design, a generalizability theory[16] approach was used. Generalizability theory allows researchers to estimate the variance per source,[17] thus permitting the use of all data from both sessions for each child. A random-effects ANOVA was used to estimate sources of variance and create g-coefficients (varying from 0.0 to 1.0) for each source of interest.[18] G-coefficients are similar to intra-class correlation coefficients (ICCs),[17]and can be compared against traditional benchmark values of 0.40 or below as low, 0.40- 0.75 as moderate to good and 0.75 and higher as excellent reliability.[19] Confidence intervals, however, cannot be calculated. Due to non-parametric assumptions regarding independence of observation, kappas were calculated per session for inter-rater agreement for the MLSRI's two categorical items. Absolute reliability was evaluated by the standard error of measurement (SEM) at the 95% confidence level and the Bland-Altman method to evaluate measurement bias for each intervention (usual and VR). A repeated measures ANOVA was used to determine main effects and interactions between raters, interventions, and occasions (i.e. session 1 or 2) for all feasibility outcomes (i.e. confidence, difficulty and time to rate). SPSS v. 17.0 was used for all analyses.

Results

Participant demographics

Eleven children and youth (7 males and 4 females) with ABI participated in the study. Children were between 8 and 18 years of age (mean 12.4, SD 3.4 years). Ten had sustained a non-traumatic ABI (3 had a brain tumour, 7 had other etiologies). The average time since ABI was 12.18 months (SD 3.92 months). One participant had a previously diagnosed ABI, 1 had a developmental disability and 2 had learning disabilities. The GMFM total mean score on admission to the centre was 68.4% (SD 34.4%). Four female physical therapists participated in the study; each enrolled between 1 and 4 children. Therapists had a mean of 19.5 years (SD 10.8 years) experience of which a mean of 15 years (SD 8.6 years) involved working with children and youth with ABI at this centre. Each had 6-12 months experience using the Wii system.

MLSRI data per rater

Table 2 presents the mean scores per rater per intervention. Table 3 presents the differences in these mean scores between raters for each intervention. The VR category demonstrated the greatest difference between rater mean scores.

<<insert Table 2 here>>

<<insert Table 3 here>>

Inter-rater reliability

G-coefficients for inter-rater reliability of the MLSRI total score were 0.81 for the usual interventions and 0.28 for the VR interventions. SEM for usual interventions was 2.8% and was 4.7% for VR. Bland-Altman graphs suggest no systematic biases between raters in MLSRI scores for either intervention (Figures 3 and 4). G-coefficients, shown in Table 4 for the six categories of the MLSRI, varied from 0.36 to 0.65 for usual interventions and from 0.17 to 0.72 for VR interventions.

<<insert Table 4 here>>

<<insert Figures 3 and 4 here>>

Feasibility of MLSRI rating

Table 5 provides descriptive results of the feasibility outcomes summarized per rater and per intervention.

The repeated measures ANOVA showed no significant differences by rater, intervention, or occasions in difficulty completing the MLSRI. Rater 1 was more confident than rater 2 in completing the MLSRI ($p = 0.05$), and this effect was dependent on the intervention, occurring with the VR ratings ($p=.036$). There was a significant main effect for difference between raters for time to complete the MLSRI, with rater 2 taking more time than rater 1 ($p <0.001$), and also for the difference between interventions with VR taking less time to rate than usual interventions ($p = 0.003$). Usual interventions were an average of 34.5 minutes (SD 7.5 minutes) long while the length of VR interventions was an average of 14.5 minutes (SD 5.6 minutes).

<<insert Table 5 here>>

Discussion

Inter-rater reliability of the MLSRI depends on the type of intervention. The excellent inter-rater reliability for usual sessions for the total score demonstrates that it is possible for raters to consistently use the MLSRI to differentiate between observed MLS use between videotaped intervention sessions. This enables MLSRI use in research studies in which the goal is to understand differences in MLS application between different therapists, intervention approaches, or children. However, category score inter-rater reliability g-coefficients were only adequate for usual interventions, though they were improved in 3 out of the 5 categories (instructions, practice, and conduct) as compared to the ICCs achieved in the previous investigation.[15] The inter-rater reliability for the total score (g-coefficient 0.81) is also improved from previous testing with this population, in which the ICC was 0.50.[15] This improvement may be due to greater clarity in item definitions and/or more rater experience with the instrument.

In contrast, inter-rater reliability for the VR intervention total score was poor. Several possible explanations are proposed. Because the VR intervention videotapes were of shorter duration than the usual components, there was less total time for raters to observe therapists interacting with clients, undertaking different tasks, or indeed demonstrating any of the actions or verbalizations relevant to the MLSRI. This difference in intervention length meant that raters had to make decisions based on fewer data points than were available for usual interventions. Understanding whether these data points themselves were homogeneous as compared to usual interventions requires a task analysis of the VR videotape components. Without such an analysis, we can only hypothesize as to whether or not VR was used in similar ways with all children at both time points, which would reduce both the intra-subject and the inter-subject variance.

Rater familiarity with the VR games that were being used by therapists is another possible influence on inter-rater reliability. Videotapes were only able to capture the child and therapist, not the television screen; without being familiar with the features of the game being played, it may have been challenging for raters to make decisions about rating some MLSRI items. For example, raters may not have been aware when games were changed or progressed unless the therapist or the child made a comment.

Differences between rater mean scores illustrate that the most problematic categories of the MLSRI for VR interventions were 'practice', 'conduct' and 'VR'. Despite the provision of VR-specific instructions with respect to item rating, several items on the MLSRI may be more challenging to rate for VR interventions than for usual interventions. For example, items within the 'practice' category including 'repetitive', 'whole (rather than part)', variable (rather than constant)', and 'progressive' may have been more difficult to rate when raters did not have a good understanding of which game was being played, when games were changed or when difficulty levels were progressed, or whether different games were of differing challenge levels. The question of whether a single trial of a VR game could in itself represent variable practice (given the potential for needing to react in different ways to unexpected and changing stimuli) was not addressed. Items within the conduct category may also have been more challenging to rate for VR interventions where differences in games were difficult to capture or where fewer environmental resources may have been used. Lastly, the three VR category items are among the most subjective on the instrument, requiring raters to judge both child and therapist intent behind observed verbalizations, actions, or facial expressions. These are the only items that endeavour to capture how the therapist capitalizes on the purported motor learning attributes of the Wii system itself (i.e., visual or auditory information and the motivation that it provides). Capturing whether or not the Wii features in themselves may be offering motor learning benefits is important, but the results demonstrate that these items require clarification.

Finally, the two categorical items demonstrated varying degrees of agreement per session for each intervention. The presence of another person in the room as a caregiver (item 30) may not have been identified as such, and the nature of recommendations for task practice outside of therapy (item 31) may not have been sufficiently clearly defined within the rater training materials. These items represent the motor learning variables of amount of practice and transfer/generalization to real-world tasks. In addition to revisiting rater training materials for these items, it will be important to consider whether they could be changed to a 5-point scale, as opposed to capturing presence or absence with a categorical 'yes or no' response. Without further clarification for raters, doing so would likely further decrease the reliability of the instrument, given the already poor agreement seen in this study.

Implications for clinical and research use of the MLSRI

The high inter-rater reliability for usual interventions suggests that the MLSRI could be used by trained PT raters in clinical practice. However, raters in this study required a time intensive training process, which may limit clinical applicability. In research, the instrument may be used to compare use of MLS between different rehabilitation settings or between therapists. The MLSRI requires responsiveness evaluation if it is to be used to measure change over time, for example before or after a therapist takes part in a knowledge translation initiative about MLS use.

Issues with the reliability for rating VR interventions limit recommendations for use in this area. Further work with the instrument for these interventions is needed to address whether these issues relate to rater training or experience with VR, to issues with the instrument, to logistical issues with the videotapes, or to the ways in which the therapists used the VR in this study. It also limits ability to explore differences in MLS use between usual and VR interventions.

Ultimately, with further refinements, the clinical potential of the MLSRI is in description and measurement of the motor learning content of interventions for children and youth with ABI. This will enhance our understanding of clinical practice in this area and allow for exploration of whether MLS use influences the motor learning outcomes important to physical therapists, such as retention and transfer of skills learned in therapy to daily life activities.

Limitations

There was a systematic pattern of differences between raters (i.e. the mean scores demonstrate that Rater 1 consistently awarded lower scores than did Rater 2, except for in the ‘guidance’ category for both interventions). While this pattern also occurred in usual ratings, it was of a lesser magnitude. This difference between raters, whatever the cause, decreases the reliability of VR rating, which limits the ability to understand MLS use in

VR interventions at this time and prevents the comparison of MLS between usual and VR interventions. These two raters had each achieved excellent intra-rater reliability in a previous study.[15] Raters were physiotherapy students who did not have a great deal of experience either providing or observing therapy sessions. While this lack of preconceived opinions may have been a positive in terms of augmenting the influence of rater training, the lack of experience may have affected their ability to recognize some MLS and to judge therapeutic intent of observed interventions if they were more subtle, perhaps causing them to question their judgment and leading to more variable ratings.

Confidence intervals around the reliability g-coefficients could not be obtained, which has an impact on interpretation of estimate precision.

As new commercially-available VR video games are developed and integrated into practice it will be important to understand whether the VR-specific items are relevant to these new technologies. The study's small sample size likely led to not enough variance in use of MLS between therapists and between videotapes, which was compounded for VR interventions by their decreased duration. Capturing each client at two occasions during their rehabilitation was a strategy to address this, but it may be that therapists adopt a particular approach or style with an individual child or it may be that they have a particular approach or style in general that is invariant, regardless of the child. It is also possible that the time between the two occasions may not have been long enough to capture any changes in the child that would cause the therapists to use MLS differently.

Future directions

The MLSRI can be used to determine if MLS application within usual interventions is related to intervention outcomes or to child characteristics. Using the MLSRI to determine which MLS are used most frequently in practice may inform research to specifically evaluate the effectiveness of those MLS. It is clear that use of the MLSRI to rate VR interventions requires further validity work, development of rater training materials and reliability investigations. In general, little is known about how using VR influences therapist behavior and decision-making. A greater understanding of this may contribute to the development of further MLSRI items specific to use of the VR. Subsequent studies require larger sample sizes and greater diversity in therapists and practice settings.

Conclusions

Exploring the use of MLS is an important perspective from which to describe physiotherapy interventions for children and youth with ABI. The MLSRI, a newly-developed instrument to quantify use of MLS in practice, demonstrated excellent reliability for usual interventions. Issues with rater training, instrument item relevance to VR interventions, and characteristics of the videotaped sessions had an impact on the instrument's reliability during VR interventions. It appears that the MLSRI could be a useful tool to measure the MLS content of usual interventions for children and youth with ABI.

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Figure 1

A clinical decision-making process outlining how therapists can use motor learning strategies in practice. Motor learning strategies are observable therapeutic actions involving the selection, manipulation and application of a motor learning variable according to client and task specific factors and with consideration of motor learning principles.

Figure 1: The motor learning strategy clinical decision-making process

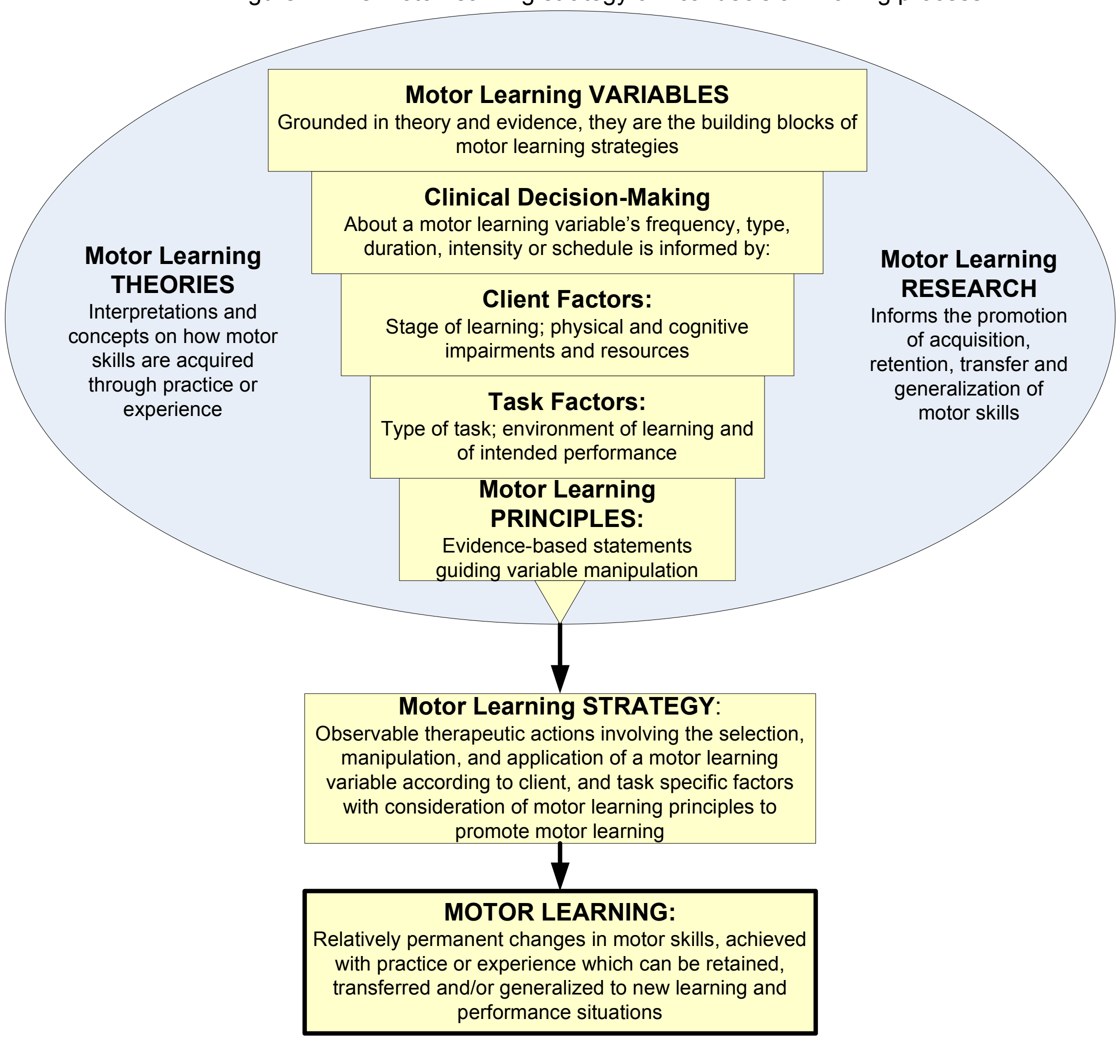

Figure 2: Study design

The study's repeated-measures observational design in which participants received both usual and VR interventions in each of two therapy sessions, with ratings by two raters of each intervention at each session.

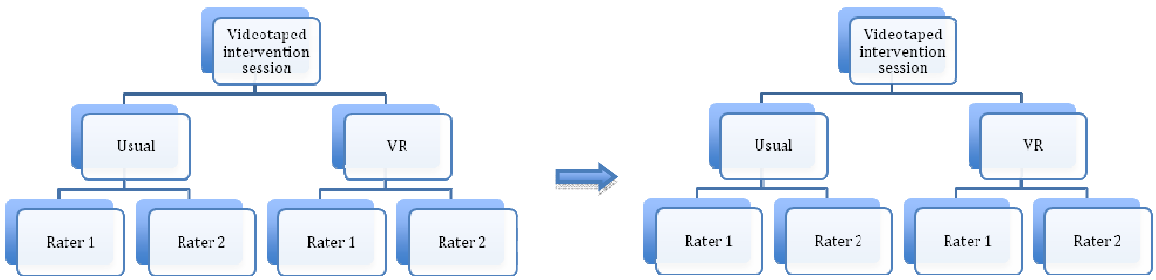

Figure 3: Bland Altman for usual interventions

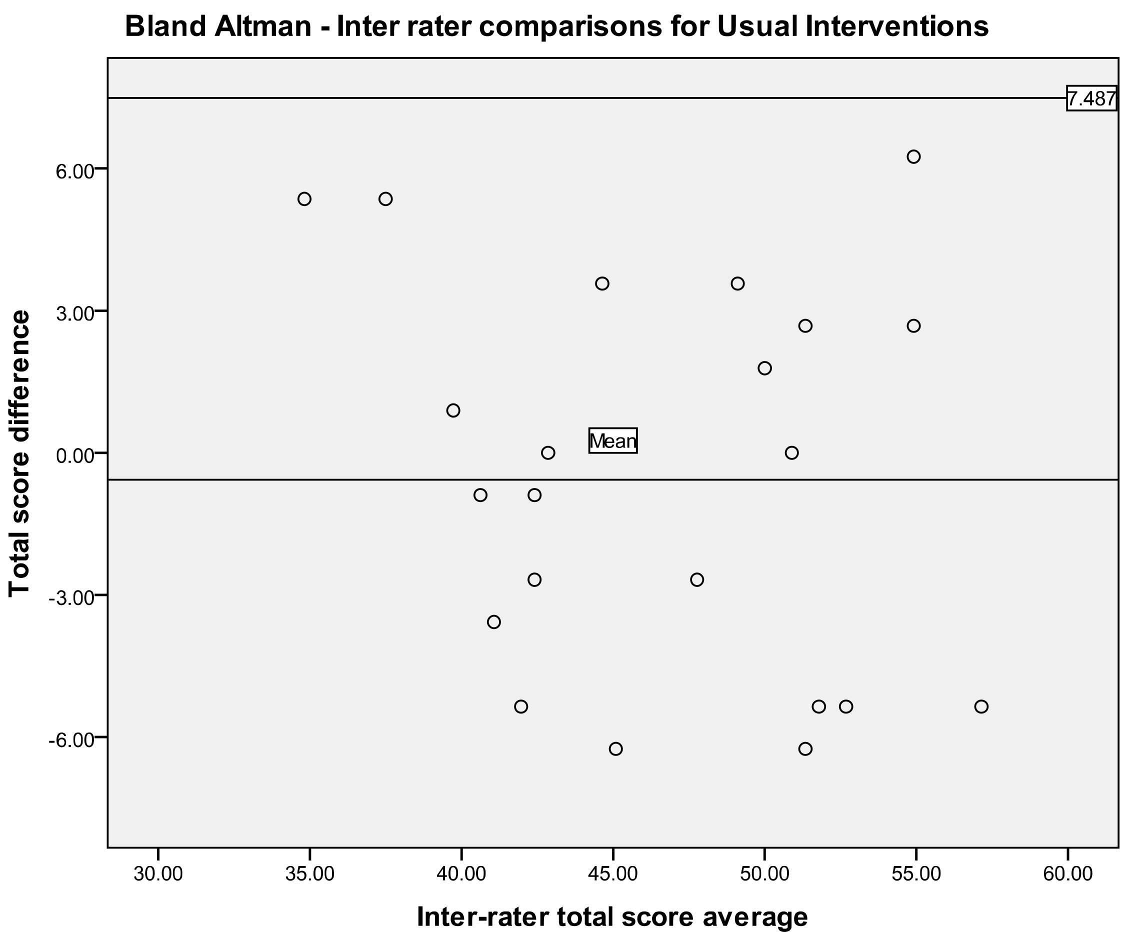

Figure 4: Bland Altman for VR interventions

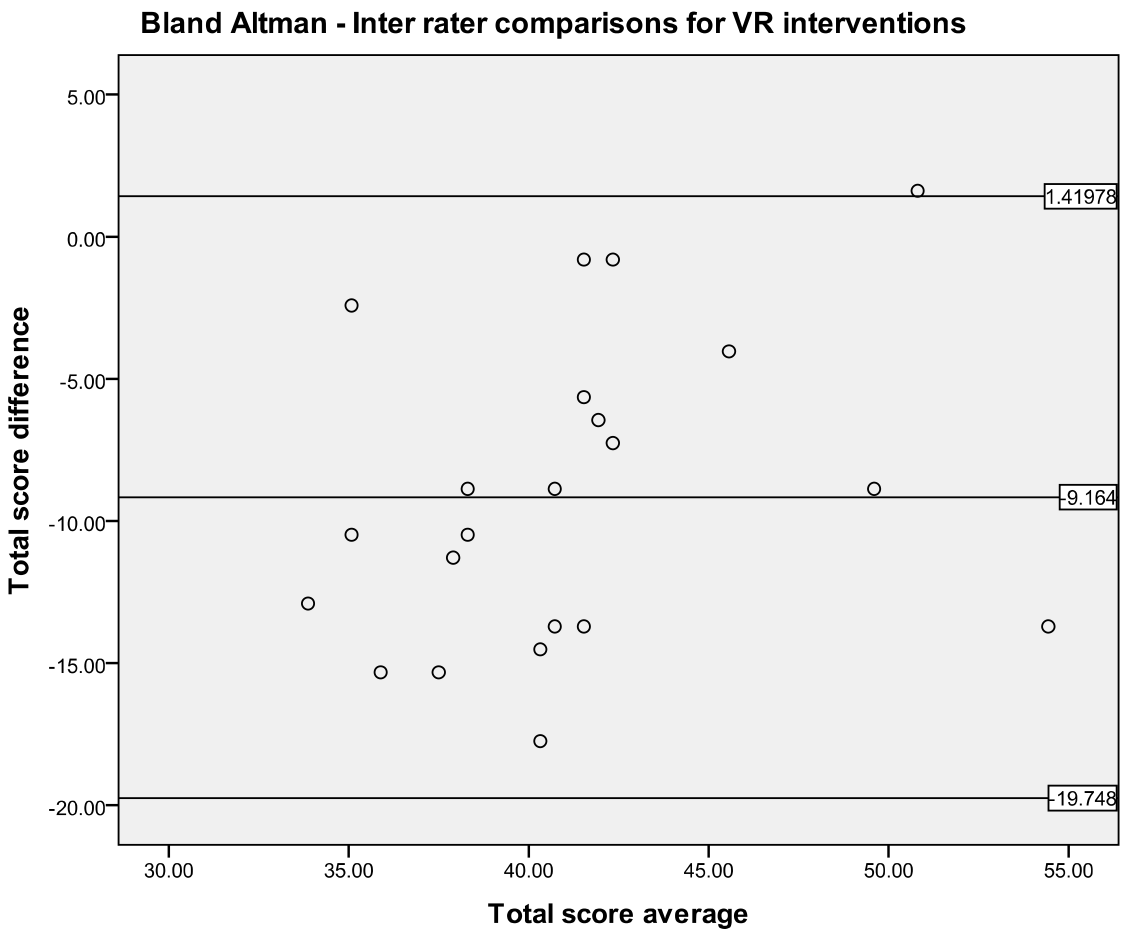

Table 1: MLSRI item examples

Category	Item examples
Therapist verbalizations	• the physical therapist's provision of instructions that direct the child's focus of attention internally or externally • feedback that addresses knowledge of performance or knowledge of results
Child verbalizations	• extent to which the child verbalized about the task or was encouraged to verbalize by the physical therapist • the extent to which the child's verbalizations demonstrated problem-solving or teaching
Practice	• extent to which tasks were active, repetitive, whole versus component-based, variable, challenging and progressive
Guidance	• extent to which demonstration, physical guidance and mental practice are used
Conduct	• use of environmental resources • level of child motivation and need for redirection • creation of an environment where errors are a part of learning
VR	• extent to which the VR was used with therapeutic intent • how attentive and responsive the child and physical therapist are to the visual and auditory information provided by the VR

Table 2: Rater mean scores

	Rater 1		Rater 2	
	Usual (n=22)	VR (n=22)	Usual (n=22)	VR (n=22)_
Therapist verbalizations	43.9 (6.0)	32.4 (9.5)	47.3 (9.4)	36.1 (9.0)
Child verbalizations	21.6 (9.5)	20.8 (8.8)	30.3 (14.9)	25.4 (11.9)
Practice	65.1 (8.0)	55.5 (8.0)	69.3 (8.9)	68.8 (9.7)
Guidance	25.4 (10.4)	15.9 (12.3)	20.0 (9.8)	9.8 (9.1)
Conduct	44.5 (10.3)	31.8 (6.6)	45.5 (9.4)	38.3 (5.6)
VR	N/A	58.7 (12.2)	N/A	75.8 (9.9)
TOTAL score	46.3 (6.2)	36.6 (6.4)	46.9 (6.9)	46.7 (5.1)

Table 3: Differences* between rater 1 and 2 in mean scores

	Usual (n=22)	VR (n=22)
Therapist verbalizations	3.4	3.7
Child verbalizations	8.7	4.6
Practice	4.2	13.3
Guidance	-5.4	-6.1
Conduct	1	6.5
VR	NA	17.1
TOTAL score	0.6	10.1

*Rater 2 – Rater 1

Table 4: MLSRI category g-coefficients and Kappas

	G-coefficients Usual interventions		G-coefficients VR interventions	
Therapist verbalizations	0.65		0.72	
Child verbalizations	0.55		0.30	
Practice	0.45		0.17	
Guidance	0.36		0.65	
Conduct	0.55		0.19	
VR	n/a		0.20	
Item 29-"Recommends practice outside of therapy"	Kappa statistics Session1 0.42 (CI 0-1)	Kappa statistics Session2 0.00	Kappa statistics Session1 0.00	Kappa statistics Session2 1.00
Item 30- "Education/homework to caregiver"	0.42 (CI 0-1)	1.00	0.13 (CI 0-0.45)	0.63 (CI 0-1)

Table 5: Feasibility descriptives

	Rater 1 (mean, SD)	Rater 2 (mean, SD)
USUAL		
Difficulty to complete (/10)	6.9 (0.9)	7.5 (1.4)
Confidence to complete (/10)	7.3 (0.80)	7.3 (1.2)
Time to complete (minutes)	77.5 (15.2)	81.1 (19.7)
VR		
Difficulty to complete (/10)	7.3 (1.1)	7.1 (1.2)
Confidence to complete (/10)	7.6 (1.2)	6.2 (1.5)
Time to complete (minutes)	37.7 (13.0)	39.4 (12.9)

Chapter Five

Title of paper: Usual and virtual reality video game-based physiotherapy interventions for children and youth with acquired brain injuries

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Abstract

Little is known about how therapists promote learning of functional motor skills for children with acquired brain injuries (ABI). This study explores physiotherapists' description of these interventions in comparison to virtual reality (VR) video game-based therapy. Six physiotherapists employed at a children's rehabilitation centre participated in semi-structured interviews which were transcribed and analyzed using thematic analysis. Physiotherapists describe using interventions that motivate children to challenge performance quality and optimize real-life functioning. Intervention strategies are influenced by characteristics of the child, parent availability to practice skills outside therapy and therapist experience. VR use motivates children to participate but can influence therapist use of verbal strategies and complicate interventions. Physiotherapists consider unique characteristics of this population when providing interventions that promote learning of motor skills. The VR technology has advantageous features but its use with this population can be challenging; further research is recommended.

Acquired brain injuries (ABI) are a leading cause of disability in Canadian children and youth (Campbell, Kuehn, Richards, Ventureyra, & Hutchison, 2004). Children with moderate and severe ABI often receive interventions within in-patient rehabilitation settings to regain gross motor, mobility, and balance skills and support re-integration in home, school and community activities (Dumas, Haley, Carey, & Shen Ni, 2004; Haley, Baryza, & Webster, 1992). A retrospective study reported that therapeutic exercise was the most frequently provided type of intervention in an early rehabilitation setting (Dumas et al., 2004). However, a paucity of research in this area (Bedell, Haley, Coster, & Smith, 2002; Teplicky et al., 2005) limits greater description of physiotherapy intervention content for children and youth with ABI in early rehabilitation. Gaining a better understanding of intervention content could elucidate the theoretical underpinnings of practice, inform professional development opportunities and promote evidence-informed care.

The content of intervention is poorly described within rehabilitation as a whole (Whyte & Hart, 2003). Describing this content involves not only the nature of therapeutic activities but also the therapist-client interactions that occur (Whyte & Hart, 2003). Unless specific content is able to be described, interventions that have been evaluated and reported in the literature cannot easily be replicated by clinicians (Whyte & Hart, 2003). Whyte and Hart (2003) suggest that researchers select a specific focus when endeavoring to describe intervention content. Following an ABI, rehabilitation may provide critical learning opportunities in order to influence the cortical mechanisms of neuroplasticity that are affected by post-injury behaviour (Johnston, 2009; Nudo, Plautz, & Frost, 2001).

Relearning motor skills and learning new motor skills is important for children and youth with ABI (Giza, Kolb, Harris, Asarnow, & Prins, 2009). Therefore, a relevant focus is to describe the content of physiotherapy interventions intended to promote learning or relearning of functional motor skills.

Researchers and educators encourage the application of motor learning theories to support therapists in this goal (Larin, 2006; Zwicker & Harris, 2009). In highlighting the relevance of motor learning theories within pediatric practice, Zwicker and Harris (2009) suggest that they may be challenging for therapists to operationalize in practice. Therapists may demonstrate varying degrees of implicit and explicit awareness about motor learning (Larin, 2007), and may require more information to support the integration of motor learning concepts within their interventions (Hayes, McEwen, Lovett, Sheldon, & Smith, 1999). There is evidence, however, that therapists greatly base decisions about their interventions on informal sources of evidence such as client characteristics and previous clinical experience (McGlynn & Cott, 2007). It is likely that the known cognitive, memory or behavioural impairments of children with ABI (Babikian & Asarnow, 2009) may be important influences on intervention content.

Intervention content may also be influenced by the integration of new technologies such as Nintendo's commercially-available virtual reality (VR) video games Wii and WiiFit[h] . However, few reports exist to inform therapists interested in using these interactive games within clinical practice (e.g. Deutsch, Borbely, Filler, Huhn, Guarrera-Bowlby, 2008; Halton, 2008). These entertaining and accessible VR gaming consoles use

[h] Nintendo of Canada Ltd. Suite 110, 13480 Crestwood Pl, Richmond, BC , V6V2J9

motion-sensing technology to detect acceleration and orientation, allowing the child to control games by means of movement and posture (Deutsch et al., 2008). The games provide feedback, consistent repetitions of realistic tasks, and may motivate users to increase practice duration or intensity (Deutsch et al., 2008; Saposnik et al., 2010). Their specific application within pediatric physiotherapy for children and youth with ABI has not been investigated.

The purposes of this study are twofold; firstly, to explore physiotherapists' description of their interventions to promote learning and/or relearning of motor skills in children and youth with ABI; and secondly, to gain an understanding of how the use of the VR video games Wii and/or Wii Fit influences therapeutic interventions.

Methods

Design

Qualitative description explores therapy by summarizing events as they are described by the research participants and "stay[ing] close to their data and to the surface of words and events" (Sandelowski, 2000 p. 334). Ethical approval for the study was received from the [children's rehabilitation centre name and university name] Research Ethics Boards.

Participants

Six female physiotherapists participated in the study. Participants had between 6 and 40 years of clinical experience (mean 22.2 years, standard deviation [SD] 12.2 years) with between 4 and 24 years experience working with children and youth with ABI (mean 13.16 years, SD 7.4 years). Therapists had been using the Wii in their clinical practice for 6 to 12 months. Only one participant reported using the Wii for personal recreation.

The participants were purposively sampled from physiotherapists employed in the brain injury rehabilitation unit at a children's rehabilitation centre in Ontario, Canada, as these cases were deemed information-rich for the study purpose. Physiotherapists provide care to children and youth with ABI aged 4 to 18 years in both in- and out-patient programs. Clients typically receive rehabilitation services at this centre following hospitalization or other medical/surgical intervention for an acute traumatic or acquired brain injury. Participants were recruited through a face-to-face research meeting. During the recruitment and consent process, therapists were informed that the purpose of the interviews was to explore the content of their interventions, including their use of the Wii.

Procedure

Semi-structured interviews were used to collect data. An interview guide was developed (see Appendix 1, p.150). The guide was field-tested with two physiotherapists working with youth with ABI to ensure question clarity. Open-ended questions prompted therapists to describe what they do or say to help children learn or relearn motor skills, and the factors that might influence these actions and decisions. As such, therapists reflected upon clients in their caseload for whom interventions to regain functional motor skills were a priority (i.e., as opposed to interventions geared towards maintaining joint range of motion, for example). Although subsequent questions were used to probe more specifically with respect to strategies, techniques or actions, no question used the specific terms ‘motor learning’, ‘motor learning theory’ or ‘motor learning strategies.’ We anticipated that, by avoiding the use of those specific words, we would not direct therapists’ responses. All interviews were conducted by the first author over a two-day period in one facility. Interviews lasted no longer than ninety minutes, were tape recorded and transcribed verbatim. Demographic data were also collected.

Data Analysis

Data were analyzed using thematic analysis as described by Braun and Clarke (2006) to “identify, analyze and report patterns (themes) in data” (p.79), capturing meaning relating to the research questions. The analysis involved the process outlined by Braun and Clarke (2006) and was completed by two investigators (DL and PM). First, transcripts were read repeatedly to obtain overall impressions. Initial codes were generated directly from the data. The investigators began by coding a single transcript independently and then met to discuss that transcript. They then met regularly to reach consensus on the codes, and to identify codes found across the six transcripts. Themes arising from the codes were identified and named. Transcripts were re-read to confirm analysis against a review of the whole text. Representative quotes, highlighting the themes, were selected to contribute to trustworthiness of the findings.

An audit trail, including the multiple notes and summaries from the analytical sessions, was kept to capture the investigators’ decisions related to analysis and coding and to document procedural rigor and the influence of authors’ beliefs (Cresswell, 2007). When analysis was completed, a member checking process was undertaken in which a descriptive summary report was sent to the participants. Five of the six therapists participated in a group discussion (facilitated by DL) and provided feedback to verify credibility of the findings (Creswell, 2007). Participants indicated support of the findings. Other procedures to maximize credibility and rigor included investigator triangulation in the analysis and the use of quotes from different participants to establish data and source triangulation (Creswell, 2007).

Results

Four themes emerged from the therapists' descriptions of their interventions to promote learning or relearning of motor skills: intervention goals, child characteristics, parental involvement, and physiotherapist experience. Three themes outline therapists' description of their VR video game-based interventions: impact on verbal strategies, VR is motivating, and VR adds complexity to therapy. The Table highlights the comparative findings for the two interventions.

<< insert Table about here >>

Interventions to Promote Learning of Motor Skills

1. Intervention goals

Physiotherapists report three goals of their interventions that influence the things that they do and say to promote learning or relearning: intent to motivate the child, address and challenge quality of movement performance, and improve function for daily activities. Within these foci, therapists describe specific strategies that help them achieve these goals.

Intervention content motivates the child

Participants want their interventions to motivate children to participate in therapy. They do this by creating a fun, positive environment that provides opportunities for the child to experience success. They rely on the provision of abundant positive verbal feedback consisting of statements encouraging or supporting and encouraging the child's efforts. They describe, *"Trying to be positive. Not being negative or discouraging. We want to really encourage them and motivate them. So we're trying to be upbeat and give a lot of positive feedback."* (Participant 3) Therapists believe a motivated child is one who may participate more actively in therapy, which, in turn, may facilitate improved outcomes. *"Keeping the patient motivated in a therapy session is very important. The more motivated, the more involved and engaged they are, the better will be your outcome…"* (Participant 4).

Intervention content addresses and challenges quality of movement performance

Participants describe intervention geared towards improving the quality of movement performance observed. Promoting quality of movement involves attending to how closely the child's movements reflect 'normal' movement, in a therapeutic effort to promote optimal performance of a movement task. One strategy to achieve this goal relates to the number of times a task is practiced. *"With balance things, you can really see that their balance just goes downhill by the time you've tried this one task a number of times. So you just sort of cut your losses and move on because you've lost the quality so you're not really getting the benefits of trying it any longer"* (Participant 1). Therapists select increasingly challenging activities in order to progress the difficulty of the desired activity. *"You want to challenge them. So if equipment I'm using isn't challenging* *enough, I'll take it up to the next level. And I always try to take kids to a level beyond what they can do, as long as they have the confidence and the trust to try it"* (Participant 6).

Intervention content optimizes real-life function

Physiotherapists describe that what they say and do in therapy is designed to promote function for real-life activities, in which the goal is for the child to be independent and functional outside of therapy sessions. They described various strategies used to do this, such as decreasing the amount of physical handling and verbal feedback that they provide during therapy. *"I think you do whatever you can to get the child to figure it out. And the more you can do it without your hands on them, the better. Because they've got to be able to replicate it"* (Participant 2).

Therapists also aim to vary the practice opportunities that they provide for the child and practice in different environments. Therapists spoke about recognizing that therapy activities do not necessarily parallel real life and wanting the child to have the opportunity to practice tasks in different ways. One therapist said, *"So if you're varying things, then it gives you sort of a more realistic, or as realistic as it can be in an artificial setting. You're just trying to sort of mimic what they might be experiencing, say, in their school day or at home."* (Participant 1) Similarly, another commented *"In real life, the child isn't going to have to balance on just on one surface, they're going to have a multitude of surfaces out there, so you change it up all the time"* (Participant 5).

Finally, therapists described promoting function by educating parents and caregivers that participation in daily activities is as important as therapy for the child's recovery. *"I really try to get families to understand that things they do on weekends, the recreation they do in the evenings is all part of the rehabilitation process. So if you're working on something like walking . . . . You know, the walking they can do on a unit, with the nursing staff, with their family on the weekend in the house, that is all beneficial"* (Participant 2).

2. Matching strategies to child characteristics

The heterogeneous characteristics and complex impairments of children with ABI in the post-acute rehabilitation stage of their recovery influence the strategies that therapists describe using within their interventions to promote learning/relearning. Cognitive and memory limitations were the most prevalent influences on the verbal and physical strategies that therapists use to promote learning/relearning. Therapists spoke about using strategies such as provision of verbal instructions and feedback to improve the child's understanding of task requirements: *"…you've got someone with a brain injury who's overwhelmed by stimulus, you're going to have to decrease that [verbal feedback] and give a lot less stimulus…if too much feedback is over-stimulating for that child, and they can't take it all in, then I'll reduce the amount of speaking, for example"* (Participant 2).

When tasks involve a series of steps or a complicated end-point, therapists use demonstration as a strategy. This is often done as an alternative to verbal instruction because the therapist feels that it helps the child understand the requirements of the movement. *"I think sometimes when we break down a task… and we're doing things that they're not normally used to, like stepping up onto a block… I think it's necessary to sort* *of show them first. There can be too many steps involved, that cognitively it would be too confusing. So it's easier to just show them"* (Participant 3).

Physical handling is another strategy that therapists use to help children understand what they movement should feel like when cognitive abilities limit the use of verbal strategies. *"….so much of learning is doing. But the person has to understand it, so that's the key. Let's say we're working on sit to stand, and you want to work on weight-shift. Well, do they understand what you're trying to get them to do? . . . . You may have to more hand-over-hand, where you're going to spend all your time bringing them forward and having them stand up. That's different than cognitively understand, 'Okay, sit up, lean forward, weight-shift forward'* (Participant 2).

Finally, therapists describe a strategy of breaking a whole task down into parts when the child is having difficulty understanding how to complete the whole movement sequence. *"…with specific repetitions of something it'll be, 'Okay this time, you just need to focus on 'x' and don't worry about the rest.' And then, once they've sort of figured that out, 'Okay, let's move on and look at 'y'.' …as you're doing it you can sort of see clearly what is not being understood and what is being understood"* (Participant 1).

3. Parental involvement

Physiotherapists describe the importance of providing education and homework to parents and/or caregivers in order to encourage them to practice motor skills with the child outside of scheduled therapy sessions. Therapists educate parents and provide homework to increase the amount of practice that children receive and to help parents know how to safely assist the child without therapist supervision. *"I don't think, in our* *therapy, even every day is adequate. I was just talking to a parent this morning that the way they hold a child is therapy. . . .At home, walking your child up and down the stairs, in the way to make sure it's safe but challenging, is therapy. . . .During the treatment sessions I can make [the child] do 2 or 3 times. But throughout the day, you can practice and practice and practice. So I think that parent education is very important"* (Participant 4).

4. Physiotherapist experience

Physiotherapists described the following as influencing their intervention content: their own past experiences of what has worked well with children and youth with ABI, their interactions with students they supervise in terms of keeping current with the literature and the expertise of other professionals on the ABI team with whom they discussed care.

Professional development activities and experience appear to influence whether a therapist reported focusing on a particular form of therapeutic intervention. One therapist commented,*"I do a lot of facilitating. I think that's because of my background, I'm NDT [Neurodevelopmental Therapy] trained"* (Participant 3). Therapists also describe using information from post-graduate courses to inform intervention content. *"I mean, if it's really specific to say, the number of repetitions and things like that, then it is continuing education courses that have gone on in different, sort of theoretical approaches that people have"* (Participant 1).

VR video game-based intervention

Three themes were identified within physiotherapist descriptions of their use of VR. Therapists described using VR to promote balance, strength, coordination, and endurance. They also described using it as a means of achieving a secondary movement goal (such as a type of movement or sustained positioning) and as a reward.

1. Impact of Wii on verbal strategies

Therapists describe that (how) using the Wii have (has) an impact on the amount and content of the verbal instructions and feedback that they provide to the child. Firstly, participants describe providing additional feedback and instructions when the child doesn't understand the information provided by the Wii. For example, one therapist commented *"If they don't totally clue into what all the feedback is giving you, that little piece of pie that changes, then I need to give them more feedback"* (Participant 6). This additional information needs to be of a positive nature to counteract the negative feedback that is given by the Wii. *"I still find though, it finishes, and it will say 'You're unbalanced.' Or 'You're below average,' or whatever. But I still give them the feedback of, 'But look how many fish you caught on the iceberg, or whatever, compared to last, like so I find I still have to give them that feedback because it's not always the most positive feedback that the Wii is providing them"* (Participant 3).

Alternatively, some therapists described providing less verbal information to avoid 'information overload' for the child. They suggested that the Wii itself offers too much information in the form of auditory and visual feedback and instructions for this population and that adding more would not be helpful for the child. One therapist observed*"… there's an awful lot of feedback coming out of the machine. Oh, I mean if they made a good shot, I'd tell them they made a good shot too. But you do get a lot . . .The crowd roars or doesn't.. .I don't think I would talk as much, too much information"* (Participant 5). Some therapists also consider the Wii to be a game, and the child engaged in playing may not be receptive to information directed towards learning. *"Right – feedback or instructions…I think I give less. And I think the reason I do is because it's a game. If someone's engaged in a game, how often do you want to hear, 'Shift this. Do this'"* (Participant 2).

2. VR is motivating

Therapists describe that using the Wii enhances children's motivation to participate in therapy and to practice movements that they would otherwise be reluctant to try. *'"There's no other way that I can engage a patient for so long, practicing on this balance skill with another piece of equipment. So this [using the Wii] is perfect"* (Participant 4). The Wii is familiar to many children and this familiarity also encourages movement. *"Because we're dealing with kids who are very, very familiar with video games, like you know, give them a football, and they might not know what to do with it. Give them the Wii, oh, instant. And also dealing with head injuries, so we're giving them something that they're familiar with"* (Participant 4). This motivation also encourages parents to continue therapy activities through practice with the Wii at home. One therapist described parents as being *" …very happy that their kids are doing it here, because it's something they can do on weekends with families"* (Participant 2).

3. VR adds complexity to therapy

Therapists described aspects of Wii use that complicated or challenged how they provide interventions. Firstly, using the Wii makes it more difficult for therapists to focus on the quality of movement performance because children are intent on playing. "*He was not really in the frame of mind to be actually participating in the therapy session. He was thinking about winning the game. And so even when you gave him the feedback of trying to do something the way you had asked him to do it, he would go back to flicking his wrists, or doing the little movements. So it was very challenging, from that perspective*" (Participant 1).

Secondly, the commercial nature of this VR system, the fact that it can be difficult to manipulate the options available for specific rehabilitation purposes to achieve the right level of challenge for the child, and the need to be knowledgeable about the games in order to recognize which one may be appropriate for a particular goal means that it is not always ideal. *"The other factor is, sort of the level of challenge of the game. So some of them are inherently more difficult than others. And it might be too much for them, or it might be too easy for them, depending on the level"* (Participant 1). Therapists also described the Wii as not appropriate for all children, particularly those with cognitive or attention impairments. *"We wanted to work on balance, but he had ataxia, and it was just too difficult. And he got too frustrated . . . .there was just too much going on, for him to have to try and play the game and keep his balance and try to follow everything . . he just did not enjoy it at all"* (Participant 3).

Lastly, therapists spoke about their need for training and experience to gain confidence in using the Wii. *"I wouldn't get a child to do something that I hadn't tried so I know what it feels like. Cause I want to know where the cheats of the movements are"* (Participant 6). *"It's just important that we went out and tried out some of the things and experience some of the movements to determine whether it was appropriate, so you're knowing what the client has to be able to do, in order to successfully accomplish or complete the game"* (Participant 1).

Discussion

Interventions to Promote Learning of Motor Skills

A purposive sample of six physiotherapists working with children and youth with ABI described their interventions as having specific goals and outlined different strategies through which they achieved those goals. These strategies and goals reflect concepts described within motor learning theories (Larin, 2006; Schmidt, 1991; Schmidt & Lee, 2005; Zwicker & Harris, 2009). Although therapists did not specifically mention motor learning theory within their responses, the findings suggest that they use some motor learning strategies and that they focus on transfer and generalization of skills to real-life activities. Indeed, when enhancing motivation to participate in therapy, addressing the quality of movement performance and improving function for real life, they use strategies such as repeated, part and variable practice; verbal instructions and feedback; demonstration; guidance; and progression of activity challenge. Therapists described the importance of gradually reducing the amount of verbal and physical assistance they provided to the child as he or she gained function and independence. They emphasized the role of motivation to ensure participation in therapy aimed at promoting independent functioning for real-life activities. Other studies of pediatric therapists have suggested implicit knowledge (through description of use) of motor learning strategies and concepts (Hayes et al., 1999; Larin, 2007); however, whether therapists were explicitly considering motor learning concepts when describing their practice is unknown.

Many of the strategies that therapists described may have relevance to theoretical perspectives other than motor learning. Indeed, pediatric physiotherapy interventions are varied and a number of factors influence intervention content (Chiarello et al., 2005; Kaminker, Chiarello, O'Neil, & Dichter, 2004). For example, increasing the amount of practice or repetitions to regain strength is an important principle of exercise science. Involving parents in treatment is central to tenets of family-centered care (Law et al., 2005). Therapist education and experience are important influences on intervention content and, in this study, we heard about the influence of training in NDT (Butler & Darrah, 2001). NDT's theoretical basis emphasizes the importance of regaining normal movement within recovery from neurological injury and may encourage the use of physical guidance to promote normal movement patterns. These findings potentially demonstrate a variety of theories that may influence practice but, in order to increase understanding of which theories were informing our participants, more specific questions would have been needed.

The unique impairments of children and youth with ABI were important factors influencing the strategies used by the therapists in this study. Informal sources of evidence including clinical information from client assessment are known to influence decision-making (Chiarello et al., 2005; McGlynn & Cott, 2007). Our study findings demonstrate that therapists gave serious consideration to the child's cognition, memory and attention and their ability to understand instructions in order to structure therapy so that the child could participate and learn successfully. These findings indicate that therapists were aligned with Valvano's (2004) recommendations within her 'activity-focused' model that therapists should adapt the information they have from theory and research to the characteristics and needs of individual clients.

The needs of this population in the post-acute rehabilitation phase may influence therapists' focus on promoting quality of movement performance within their interventions. At this early stage of recovery, it may be challenging for therapists to determine whether or not children will have long-term disability from their injuries. Although therapists emphasize independence and function within their interventions, they also describe working to regain movement and skill normality. Focusing on quality of movement is likely a component of working on function for real-life activities for therapists and the two goals may be viewed as inseparable. Indeed, whether to focus on immediate quality of performance to "fix" the child's impairments or on learning/relearning of motor skills to promote function has long been debated in the pediatric rehabilitation literature (e.g. Gibson et al., 2009; Law et al., 2007).

VR video game-based interventions

While anecdotal reports in the popular news media describe Wii use in various populations and settings (e.g. The Associated Press, 2008), therapists have little but empirical information on which to base the integration of this technology into practice. Wii use was relatively new for the therapists in this study and goals of this intervention, as described by therapists, were less distinct. A focus on promoting desired movement was evident in therapist description of using the Wii to motivate children to undertake certain body movements or positions, but there appeared to be less emphasis in this intervention on promoting function for real-life activities. Indeed, no evidence yet exists to confirm that using any type of VR can translate to improvements in real-life function. Reviews in this area have identified this as a priority for future research to include outcomes measuring this type of transfer and generalization (Parsons, Rizzo, Rogers, & York, 2009; Sandlund, McDonough, & Hager-Ross, 2009; Snider, Majnemer, & Darsaklis, 2010).

Therapists identified fun and motivation as positive attributes aligning with their goal of motivating the child to participate in therapy. Motivation may be a key “active ingredient”, or reason why a treatment is expected to be effective (Whyte & Hart, 2003) of VR interventions (Levac, Rivard, & Missiuna, under review). Therapists may be able to take advantage of children’s interest in and familiarity with technology to achieve a variety of therapy goals. Therapists assume that the child is motivated by the Wii, but motivation has rarely been measured in VR studies (Levac et al., under review). Quantifying the extent to which children are actually motivated by using the Wii is an area for future research.

Therapist roles with respect to selecting, progressing, and adapting the intervention or interacting with the child during Wii use have not been reported in the literature. Some therapists voiced frustration regarding the challenges of using the Wii therapeutically because they found the levels, instructions and feedback of the games to not be appropriate. Therapists primarily reflected on the impact of the Wii in terms of amount and content of verbal information they provided, tailoring their use of strategies according to child cognitive issues, as they did in their other interventions. The Wii's tendency towards negative feedback did not align with their intention to create a positive therapeutic environment and therapists compensated for this with their words and behavior. Indeed, while certain features of the VR were deemed beneficial to therapy, its use appears there are also disadvantages, implying that it may not always be a tool that is easy or appropriate to use in pediatric therapy. These findings, among the first to investigate the influence of using Wii in pediatric rehabilitation, indicate that therapists were clearly able to identify how using this technology may impact on their intervention behaviors and can inform further research.

Limitations and Future Directions

Although our interview questions pertained to interventions that promote learning and/or relearning, it is impossible to know the exact therapy outcomes that participants had in mind or the particular theory(ies) that informed their description of those interventions. Since the participants in this study were a small sample of physiotherapists who work together at one urban academic rehabilitation centre, the findings may not be generalizable to therapists in other settings or representative of intervention content for children and youth with ABI at other stages of rehabilitation.

As new commercially-available VR video games are developed and integrated into rehabilitation settings, use of the Wii may decrease. However, it is likely that all new VR systems relevant to clinical practice will have similar underlying technological features such as engaging the user and requiring the clinician to posses a certain level of experience with the technology, implying that findings will be relevant to future investigations.

There are many potential influences on intervention content and clinical decision-making; asking directly about other theoretical influences would be valuable in future research initiatives. Overall, being knowledgeable about the specific content of interventions could facilitate evidence-informed practice. Furthermore, description of the content of interventions can identify gaps where professional development activities for rehabilitation professionals, such as those regarding use of the Wii, could be offered.

Conclusion

Little is known about the specific content of physiotherapy interventions for children and youth with ABI, including what therapists do and say in order to help their clients learn and/or relearn motor skills. Physiotherapists in this study described using interventions that motivate children in order to challenge the quality of motor performance and optimize real-life functioning. Selection of specific intervention strategies was influenced by characteristics of the child, the parents' availability to practice skills outside therapy and the professional experience of the therapist. However, while some of the strategies described by therapists to promote learning and/or relearning of motor skills may have been grounded in motor learning theory, other possible influences on the content of therapy were possible. Professional development activities that articulate the application of motor learning theory for the rehabilitation of children and youth with ABI may be relevant as they would involve positioning commonly-used strategies within a defined and contemporary neurological rehabilitation model. While reported to offer certain advantages over other types of therapy, there are times when VR games were not suitable, and the role of this technology in pediatric therapy requires further study. Further research to gain a better understanding of intervention content will lead to more evidence-based practice and inform knowledge translation initiatives designed to promote integration of theory in practice.

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Table 1: Descriptions of the Content of Usual and Wii/WiiFit Interventions.

Usual interventions	**VR video game-based interventions**
Motivate children to participate with a fun positive environment	Wii is fun and motivating
Improve quality of movement performance	Sometimes difficult because the child's attention is on the Wii as a game
Improve function for real-life	Therapists did not describe using the Wii in this way, although they described that it was sometimes difficult to find an activity suited to the goals of therapy
Are influenced by complex child characteristics and impairments	Child characteristics and impairments influence therapist choice to use the VR; using the Wii influences what therapists say because it may overwhelm or confuse ABI clients
Are influenced by parent involvement	Increases opportunities for parent-led practice at home
Are influenced by therapist experience	Some therapists indicated that their lack of familiarity with the VR challenged its suitability as a therapy modality

Appendix A: Interview Guide

One of the things that we do as PTs is help children learn or relearn skills or tasks and be able to apply those skills in their daily lives, outside of therapy. There are different strategies that can use to do this.

1. What are some of the things that you do in therapy that may help kids learn or relearn skills/tasks?

2. Are there some things that you do in therapy that may help kids do those same skills/tasks in their everyday activities, once they go home?

3. What factors do you consider when you decide what to do during your physiotherapy interventions for children with ABI?

4. How do you decide which tasks to practice?

5. How do you decide on how often you have kids practice tasks?

6. When you have a child practice a task, do you ask them to practice the whole thing or do you break it up into parts? Why or why not?

7. When you have a child practice a task repeatedly, how do you decide whether to keep the task the same or vary it in some way?

8. Do you usually vary tasks? Why or why not?

9. During a session, how do you decide in what order you have kids practice tasks?

10. How do you decide whether or not a task is challenging enough for your client?

11. Do you give kids ‘homework’ or things to practice outside of therapy? Why or why not?

12. Do you ask their parents/caregivers to practice things with them? Why or why not?

13. What are some of the things that you consider when you give instructions to with a child with an ABI?

14. What are some of the things that you consider when you give feedback to a child with an ABI?

15. What does your feedback typically sound like?

16. Would you say you give a lot or a little feedback during PT sessions? Why?

17. What do you see as the role for physical handling in terms of facilitating learning? Is this something you do? If so, how do you do it?

18. What do you see as the role for demonstration in terms of facilitating learning? Is this something you do? If so, how do you do it?

19. What do you see as the role for making practice challenging in terms of facilitating learning? Is this something you do? If so, how do you do it?

20. What do you see as the role for keeping kids motivated or engaged in terms of facilitating learning? Is this something that you encourage? If so, how?

21. Can you give me some examples of the types of goals that you are working towards when you use the Wii/WiiFit with your clients?

22. What are the specific features/attributes of the Wii/WiiFit that make it a good choice for addressing these goals?

23. How do you make the decision to use the Wii/WiiFit with a particular client?

24. What makes a child with an ABI suitable for this intervention?

25. What makes a child with an ABI less suitable for this intervention?

26. How do you make decisions about progressing or modifying your client's use of the Wii/WiiFit within your interventions?

27. Can you describe/tell me about a situation in which you used the Wii/WiiFit with a client and you felt the session went really well?

28. Can you describe/tell me about a situation in which you used the Wii/WiiFit with a client and it didn't really work out in the way that you had planned?

29. In the first part of the interview we talked about some of the strategies that you use in practice. Now I would like you to think about whether using the Wii/WiiFit changes some of these strategies.

- Instructions
- Feedback
- Practice
- Modeling
- Guidance

30. If you were using the Wii/WiiFit with a client and they were having difficulty understanding how to move their body to be successful at the game, what kinds of things would you do to help them learn how be more successful?

Chapter Six: Discussion

Motor learning theories can inform decisions about the content of early rehabilitation after ABI, but little is known about how physiotherapists promote motor learning within their interventions. Physiotherapy (PT) interventions increasingly incorporate virtual reality (VR) video games, which may influence therapist use of MLS. Explore the extent to which physiotherapists use MLS in clinical practice will enable investigations to relate MLS use to client outcomes. However, this requires a valid and reliable measurement instrument. This dissertation i) reviewed the literature to identify the potential active ingredients of pediatric VR interventions; ii) developed and evaluated an instrument to measure the use of MLS in pediatric PT interventions, and iii) explored therapist perspectives on interventions used to promote motor learning in usual and VR-based therapy for children with ABI. This discussion chapter summarizes the individual study results, highlights the main findings of the dissertation, and discusses contributions to theory, practice and research within three main areas: i) the application and measurement of motor learning theoretical concepts in practice; ii) the relationship between motor learning and VR; and iii) PT interventions for children with ABI. Limitations of the overall dissertation are described and suggestions for future research directions are presented.

Overview of dissertation paper results

A scoping review of pediatric VR studies targeting motor outcomes in children with neuromotor conditions identified eleven potential active ingredients of VR that relate to system or game properties, intervention effects on the user, and therapist roles.

Few studies actually evaluated the impact of these ingredients on outcomes. Six of these active ingredients are core elements of motor learning theory, suggesting that a motor learning theoretical framework is relevant to pediatric VR interventions. The study identified the need for further detail about therapist roles within VR interventions.

Subsequently, the Motor Learning Strategy Rating Instrument (MLSRI) was developed as a way for trained observers to rate the extent to which therapists use MLS in PT interventions. Using a motor learning theoretical framework, the process also resulted in defining motor learning terms and creating a clinical decision-making process model. The MLSRI was designed to be used with both 'usual' and VR interventions. Initial psychometric property evaluation demonstrated excellent intra-rater reliability and moderate inter-rater reliability (Kamath et al., in press), leading to the need for further clarification of item definitions and rater training materials. Following these modifications, the MLSRI was then used by 2 raters to rate 22 videotaped intervention sessions with children and youth with ABI divided into usual PT intervention and use of VR interventions. The instrument demonstrated excellent total score reliability for usual interventions, but poor reliability for VR interventions. Possible contributing factors proposed to explain this poor reliability included lack of rater familiarity with VR, challenges interpreting some of the items in a VR context and issues with the logistics of videotaped sessions. While feasibility results were positive, the MLSRI required substantial rater training time, which may limit its clinical utility but not necessarily its use as a research tool.

Therapists who participated in the videotaped sessions were then interviewed to discuss their perspectives on how they describe promoting learning or relearning of motor skills within their interventions, and how this might differ with the use of VR. Physiotherapists describe selecting interventions that motivate children to challenge performance quality and optimize real-life functioning. Intervention choices are influenced by characteristics of the child, parent availability to practice skills outside therapy, and therapist experience. VR use motivates children to participate but can influence therapists' verbalizations and may complicate interventions.

Contibutions of Dissertation

Findings from the research conducted in these studies contribute to theory, practice and research within three main areas: the application and measurement of motor learning theoretical concepts in practice; exploration of the relationship between motor learning and VR; and description of the content of PT interventions for children with ABI.

Application of motor learning theory in practice

This dissertation has contributed to the application of motor learning theories in practice by presenting definitions for relevant terms, introducing a model to illustrate the decision-making process involved in selecting MLS, and developing and evaluating an instrument to measure MLS use within PT interventions.

Defining motor learning terms

Developing an instrument to measure the application of motor learning concepts within a PT session requires consistent and precise labeling and defining of the objects of measurement. Terms in current use to describe the motor learning knowledge that can inform or be applied in practice are varied and include motor learning 'factors', 'variables', 'principles', 'strategies', 'concepts', and 'conditions'. A literature review conducted early in the process of instrument development did not find any publication that defined or explained their choice of terms used.

The term *motor learning strategy (MLS)* was selected for use in this dissertation because it was judged to best reflect the active, therapist-driven decision-making required in clinical practice and evident in the MLS definition: "observable therapeutic actions involving the selection, manipulation and application of a motor learning variable according to client and task-specific factors, with consideration of motor learning principles, to promote motor learning" (Levac, Wright, Wishart, Missiuna, & DeMatteo, 2011, p. 690). While the term "strategy" has been used before in motor learning (e.g. Larin, 2007), this is the first work to specify that a MLS should involve the therapist making decisions about client-specific and task-specific factors with consideration of both motor learning theory and evidence. The dissertation defines motor learning *variables* as the building blocks of MLS, derived from theory and evidence, while *principles* provide guidelines to inform decisions about the manipulation of variables (Levac et al., 2011, p. 690).

Given the lack of pediatric evidence and the discrepancy between simple motor learning laboratory tasks and those applied within complex rehabilitation interventions, Valvano (2004) suggests that therapists should consider how their clients' characteristics and the tasks being learnt in therapy challenge the assumptions of motor learning theories or differ from recommendations derived from the evidence. The MLS definition makes this explicit for clinicians, while still emphasizing a focus on motor learning as the goal. Proposing a definition for strategies, variables and principles is a step towards a common nomenclature that can reduce confusion for students and clinicians and promote consistency among research reports.

Finally, the MLS definition acknowledges the complexity of using MLS in rehabilitation interventions. Craig, Dieppe, Macintyre, Michie, Nazareth, & Petticrew (2008) propose multiple criteria for a complex intervention. Many criteria are encapsulated in the MLS definition, including the following: i) the variety of motor learning variables and ways in which they can be manipulated (e.g. frequency, type, duration, intensity, or schedule) result in a variety of clinician behaviours and a substantial amount of flexibility or tailoring of the intervention within a specific level of adaptations; and ii) given that verbal and physical interactions with clients are a component of most intervention approaches, there could be interacting components between MLS and other interventions. The implications of considering use of MLS as a complex intervention include the need to explore the mechanisms by which MLS might improve outcomes, being clear as to the theoretical rationale behind each MLS, and defining the flexibility tolerated within MLS application in order to describe the intervention and still be able to differentiate it from other approaches.

Development of a MLS clinical decision-making process model

Defining ‘motor learning strategy’ required visually illustrating the relationship between the various factors in play within the decision-making process. A model (p. 90) was developed to outline the MLS decision-making process. It endeavors to demonstrate that motor learning theories and research provide the background knowledge to inform principles and, subsequently, decisions about variable manipulation.

Previous literature has suggested that therapists, although familiar with motor learning theoretical concepts and evidence, require guidance to apply this knowledge in practice. In particular, Hayes, McEwen, Lovett, Sheldon, & Smith (1999) surveyed members of the American Physical Therapy Association pediatric division and found that therapists were aware of recent theoretical concepts in motor learning, wanted more knowledge, and did not have the required information to support them in implementing this in practice. The model provides concrete guidance regarding the process of applying theory in clinical practice. It operationalizes the interaction between practical factors relevant to the client and task and theoretically and empirically-derived knowledge. The onus is on the clinician to be aware of this knowledge and utilize his or her experience to make decisions based on all these factors. This model may serve as the basis for knowledge translation initiatives for practicing physiotherapists or in PT education.

Findings from the qualitative study (Chapter Five) illustrate the potential relevance of the model to clinical practice in this setting. Therapists described making decisions based on client and task specific factors with goals of promoting independent function in daily life activities. However, it was not possible to ascribe knowledge or intent to facilitate motor learning to physiotherapists' descriptions of how they promoted learning of motor skills. The model may be a way to operationalize integrating motor learning thinking into existing practice decisions in that it makes explicit the variety of motor learning variables that can be considered, the ways that variables could be manipulated and the theory and evidence that would guide those decisions. Because therapists in this study were comfortable reflecting on motor learning variables such as practice, feedback, and instructions, variables that were common elements of their interventions, this model could provide the foundation for introducing a motor learning theoretical framework that would fit well with their current practice and provide a rationale for the elements that are already being implemented.

Measurement of Motor Learning Strategies

The contribution of the MLSRI instrument (p. 174-187) for clinical practice and research are described in Chapters Three and Four, including the potential for documenting changes in MLS use post-knowledge translation initiatives and also for measuring whether MLS use has an impact on child outcomes. However, the qualitative study illustrates a challenge regarding measurement of MLS in situations where therapists have not been instructed to focus on motor learning within their interventions. As with any observer-rated instrument, MLSRI raters were unable to infer the intent, reasoning, or decision-making processes underlying the observed actions. While the action captured by each MLSRI item represents the extent of variable manipulation, the challenge with labeling an observed action as a MLS is that decision-making about child, task, and principle factors and the motor learning intent may not have occurred or contributed to the observed action. Even when an action had identical behavioral indicators as an item on the MLSRI, the therapist could have been acting in that way without considering motor learning principles, which challenges the validity of labeling the observation as a MLS. This became evident in the qualitative study because therapists did not indicate that motor learning information was guiding their decision-making.

Objective measurement of intent and reasoning is impossible without therapist self-report, so the best that can be hoped for is a valid and reliable measurement of items that represent indicators of these processes. The challenge is that these indicators (i.e. the observed behaviours) could also be ascribed to other intents or theoretical influences. It could be argued that measuring the outcome of the action is still relevant, regardless of whether therapist intent can be captured. However, ignoring the intent would further close the 'black box' of rehabilitation interventions (Whyte & Hart, 2003) and would be akin to relying on the output of a machine in ignorance of its inner workings: you would be challenged to rebuild it if it broke down or if you needed to explain to others how it worked.

Larin (2007) describes similar issues with her observer-rated motor learning instrument which was designed to document content of PT interventions for children with cerebral palsy. Larin (2007) also describes substantial rater training time, but achieved better inter-rater reliability (as measured by Kappa agreement rather than intra-class correlation coefficient) in her study. The MLSRI offers an advantage, however, as Larin's instrument does not yield a score, which limits its use in research. The MLSRI is potentially more user-friendly because it provides a worksheet and involves scoring the entire session rather than rating individual activity trials. Finally, MLSRI items are more comprehensive in reflecting different motor learning theoretical perspectives and include items reflecting cognitive effort perspectives, child engagement in therapy, practice and feedback variables, and therapists' verbalizations to promote transfer and generalization.

Although the MLSRI was developed to measure the use of MLS in PT interventions for children and youth with ABI, it can be argued that its items are applicable to interventions for other pediatric populations. This is beneficial for utility of the instrument on a wider scale; population-specific validity and reliability investigations would be required.

Finally, the instrument's poor reliability in VR interventions indicates that it is not valid in this context in its current form, as reliability is a necessary condition for validity (Streiner & Norman, 2003). As discussed in Chapter 4, the problem may be related to the instrument items, to the raters, or to the ways in which VR was used or videotaped in this study.

Relationship between VR and motor learning

This dissertation provides information to support motor learning as a theoretical framework for VR clinical practice and research. Study results also suggest that improvements that could be made to a published model of the use of VR in rehabilitation (Figure 1, p.173; Weiss, Kizony, Feintuch ,Rand, & Katz, 2010) which may allow us to further understand clinician roles in VR-based therapy.

Motor learning as a theoretical framework for VR research

As described in the introduction (Chapter One), systematic reviews and research reports within the current body of pediatric VR literature contain many references to the potential motor learning attributes of VR systems. The scoping review (Chapter Two) takes this one step further by identifying which attributes are potential active ingredients of VR interventions, of which 6 emerged that relate to motor learning theory. The results challenge researchers to actually link motor learning attributes to outcomes and to study the impact of VR interventions on motor learning outcomes of transfer and generalization. The study proposes that using a motor learning theoretical framework to determine research questions, pose hypotheses, develop intervention protocols, and evaluate outcomes will facilitate this process.

Several of the active ingredients identified in the scoping review were evident in the qualitative findings (Chapter Five), including child motivation to participate, flexibility to individualize treatment parameters, practice specificity, and therapist roles. This provides preliminary validation for these active ingredients by suggesting that they are relevant to how clinicians describe decisions about factors that influence the use of VR in clinical practice.

However, an implication for practice arising from this study is in suggesting caution with respect to interpreting the traditionally-lauded motor learning attributes of VR (in particular, the abundant, multi-sensory instructions and feedback) as beneficial for all populations, as they did not appear to function in this way for children with ABI. This caution is likely relevant to other populations who have cognitive compromise as well as to younger children and those with attention deficits.

Contributions to Weiss et al. (2010) model of VR-based Rehabilitation

Weiss et al. (2010) present a ‘Model of VR-based rehabilitation within the context of terminology from the International Classification of Functioning, Disability and Health concepts' (Figure 1) that uses terminology from the International Classification of Functioning to describe the use of VR in rehabilitation. The model illustrates that task performance is influenced by user characteristics and characteristics of the virtual environment, which influence the user's sense of presence and the side effects that they experience. The model is relevant to the qualitative study findings in several ways: VR system characteristics influenced therapists' perceptions of client task performance as well as decisions about when and how to use to the Wii. These VR characteristics were viewed as both barriers and enablers, as described in Weiss et al.'s model. In addition, therapists described that user characteristics, personal factors, and goals related to improving body structures and functions influenced whether they thought the VR would be appropriate for their clients.

The model suggests that there should be a transfer phase to promote transfer of training to performance in the real world and that the clinician has a role to play in promoting this transfer, but does not give any indication of the process by which this could happen. Questions used in the qualitative study did not specifically probe this issue, and the findings did not give any information as to the role of the clinician in facilitating this transfer, as therapists did not discuss using the Wii to promote real-life skills or whether they linked Wii training to other types of activities. However, this role may be very relevant in commercially-available gaming systems such as the Wii, whose games have little ecological validity. More guidance is needed as to how therapists can promote transfer during VR-based interventions, bridging the difference between the learning environment and the environment of the intended performance.

The Weiss et al. model may not provide sufficient information to aid clinicians in using VR to meet motor learning goals. Improvements are needed to better illustrate how the process of using VR can lead to transfer and improved real world performance and to better describe therapists' roles in facilitating this transfer. To inform the Weiss model, research is needed to understand which VR system and user characteristics may facilitate or detract from this transfer process. An improved model would illustrate the process therapists should use in i) selecting VR tasks that train movements relevant to real life skills and ii) actualizing transfer and generalization to real life activities through VR-based therapy interventions.

Increased understanding of therapist roles in VR-based interventions

The scoping review identified 'role of a support person' as a potential active ingredient in VR interventions; however, the details reported about the therapist role in the intervention were inconsistent. The qualitative study is one of the first to describe therapists' perspectives about integration of a popular VR system in practice. In many ways the factors that influenced VR use were similar to factors relevant to decisions about other interventions, such as considering client characteristics, interests, and motivating a client to engage in therapy. Other factors were unique to VR, including the need to consider the cognitive as well as physical demands of the VR games, their motivational properties, their potential negative effects, and the complexity of the VR system itself to implement and manage. These factors influenced therapist actions and behaviours; therefore, it seemed that using the Wii could both augment and diminish the therapist role.

VR may reduce or replace the need for therapists because its attributes support motor learning and automate intervention delivery (Rizzo & Kim, 2005). If this is true, VR intervention protocols could be managed by therapy assistants or through tele-rehabilitation or home-based VR interventions. The results of the qualitative study do not support this perspective. Therapists did not perceive the auditory or visual feedback and instructions provided by the VR as being effective for children with ABI; rather, therapists had to interpret, mitigate or buffer these features of the VR system. Therapists also did not suggest that the ability to repeat identical practice trials, another commonly described motor learning feature of VR systems, was of benefit. The one finding that may be interpreted as VR replacing one aspect of the therapist role was the description of how the Wii allowed therapists to achieve therapeutic goals in promoting certain movements. They attributed this to motivation and to distraction of the child while playing the Wii games. This suggests that, rather than therapists working to create a fun and motivational therapeutic environment, the Wii may be a tool that can do this for them.

The motivational attributes of the Wii games could also augment what a therapist is capable of achieving during an intervention session. The qualitative findings made it clear that this is only the case when therapists are trained and comfortable with integrating the VR into practice. Many of the active ingredients identified in the scoping review require implementation, decision-making or monitoring by a therapist. Therapists in the qualitative study spoke about the need for training and experience to understand how to best match client goals and needs to what the system has to offer, how to determine the best therapeutic applications of each game and how to understand where users could potentially ‘cheat’ on movement. These results suggest that therapist training and experience may be an essential foundation for all other therapist roles in VR interventions. The therapist needs to be sufficiently familiar with the VR system that they can observe client movement performance, and interact verbally and physically with the client, without being distracted by managing the VR. The need for therapist training to develop competence and experience to make decisions using the VR system is an essential role for clinical practice and one that has not previously been highlighted within the pediatric VR literature. This is particularly important to consider in the context of this rapidly developing field, in which continual changes and advances in VR technology necessitate on-going learning for therapists.

Description of in-patient PT interventions for children with ABI

Although limited to a small number of physiotherapists in a single urban setting, the qualitative component of this dissertation has contributed the first description of in-patient interventions for children and youth with ABI specific to therapists’ perspectives on promoting the learning or relearning of motor skills. The study findings are in accordance with Larin’s (2007) study in which therapists working with children with CP also spoke about the importance of promoting motivating environmental conditions and providing positive feedback.

Focusing on how therapists promote the learning or relearning of motor skills in children with ABI is important because evidence from the study of neural plasticity suggests that motor skill acquisition is required to drive functional changes in the central nervous system after injury (Kleim & Jones, 2008). The description of practice may inform knowledge translation initiatives about motor learning for therapists in this or similar settings.

Limitations of the research

Limitations of each individual study are described within each of the manuscripts. Limitations of the dissertation as a whole are in two main areas: instrument development and study design. Development of the MSLRI was conducted under the time-restraints of a dissertation and could have been more rigorous. Although a face validity process was undertaken with motor learning experts, the use of a more formal Delphi consensus process may have led to more clear and concise item definitions. Despite the content validity process in which participants ranked item feasibility, several items involved more rater judgment than is ideal. Decisions about these items are based in observable therapist actions, but the construct being measured may still be too vague.

Although the participants did rate a VR video clip, the validity evaluation process for the MLSRI as described in Chapter Three was not specific to the instrument's use in VR interventions. The questions asked of the experts and clinicians in the survey did not specifically ask for reflection on these items in the context of VR-based interventions.

In the study comparing usual and VR interventions, MSc PT students served as raters of the MSLRI. These students had received training and had previous rating experience through their involvement in a student project evaluating the initial inter- and intra-rater reliability of the instrument (Kamath et al., in press). However, the students' limited clinical experience may have negatively affected their ability to understand what they were observing in the PT intervention, thereby reducing the reliability of the MLSRI.

Initial plans to use a mixed-methods approach led to the focus on a small number of therapists at a single rehabilitation centre. The descriptions provided of this practice setting may not be relevant or fully generalizable to other settings. Recruitment was limited by challenges involving children/youth or their parents being reluctant to participate in videotaping; this had not been an issue in a prior study of this population at this research site. Small sample size also reduced variability in the interventions and it is unclear whether therapists' use of MLS varied according to child characteristics or whether a single therapist adopted an invariant style across children. With respect to the qualitative study, the pre-determined number of therapists and the interview schedule may have had an impact on whether saturation was reached.

The poor reliability of the MLSRI with VR interventions limited the ability to examine use of MLS in usual and VR interventions, which would have provided a quantitative perspective against which to compare the qualitative study findings through use of a mixed methods analysis.

Recommendations for future research

Recommendations based on specific study findings are described in the individual manuscripts.

Reliability and validity are fluid concepts, and it is clear that the psychometric properties of the MLSRI require further evaluation. A factor analysis would strengthen the rationale for grouping the items into categories (Streiner & Norman, 2003).

Challenges with reliability within VR interventions suggest the need for a problem-solving process to determine the root of the problems and to decide whether further validity investigations are necessary to refine instrument items in order to use it to rate VR interventions.

The fact that components of MLS application, as defined in this dissertation, were unobservable may imply that use of the instrument in situations where therapists have not been instructed to focus on motor learning requires an added self-report aspect. This would need to be investigated further with therapists who had received additional training about motor learning, and those who had not.

The decision-making model may be a useful tool for knowledge translation (KT) efforts to promote use of a motor learning theoretical foundation in therapy. An established model such as the Knowledge-to-Action cycle (Graham et al., 2006) could be used to guide research endeavours to develop, implement, and evaluate a KT strategy to teach therapists how to use MLS. The MLSRI may be used as an outcome measure to evaluate pre-post change or as a vehicle to stimulate therapist reflections on their practice; however, this will require further investigation.

Summary

This dissertation has reviewed the literature to identify the potential active ingredients of pediatric VR interventions, developed and evaluated the psychometric properties of an instrument to measure the use of MLS in pediatric PT interventions, and explored therapist perspectives on promoting motor learning within usual and VR-based interventions for children with ABI. Contributions included presenting new definitions of common motor learning terms, presenting a model to illustrate the decision-making process of MLS application, developing and evaluating a Motor Learning Strategy Rating Instrument (MLSRI) to measure the motor learning content of PT interventions, and describing PT roles and potential active ingredients of VR-based interventions. A qualitative description of usual and VR-based in-patient PT interventions for children with ABI enhances our understanding of this understudied area of practice. While the MLSRI addresses an important measurement need in pediatric rehabilitation, subsequent refinement is required for its use in VR-based therapy. The results of these studies may have relevance for clinicians who are interested in using VR games with children with ABI, PT educators seeking to promote the use of motor learning concepts in clinical practice, and researchers who would like to measure the motor learning content of usual and VR-based PT interventions. This work promotes the importance of motor learning as a theoretical framework for pediatric PT practice but illustrates challenges that must be overcome to actualize this goal.

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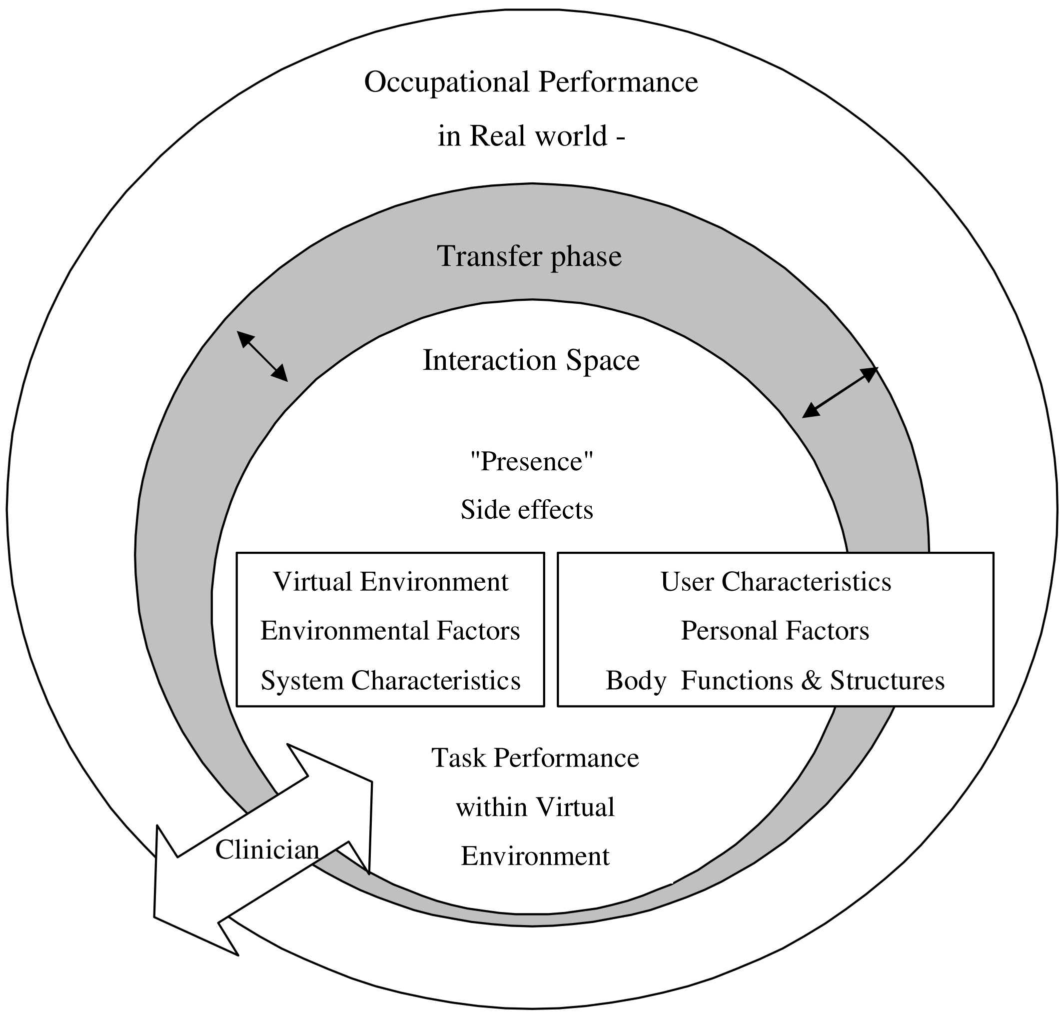
Figure 1. A model of VR-based rehabilitation within the context of terminology from the International Classification of Functioning, Disability and Health concepts.

Reproduced from: Weiss, P.L., Kizony, R., Feintuch, U., & Katz, N. (2010). Virtual Reality Applications in Neurorehabilitation. In Selzer, M., Clarke, S., Cohen, L., Duncan, P., & Sage, F. (Eds). *Textbook of Neural Repair and Rehabilitation*, *Volume 2: Medical Neurorehabilitation* (pp.182-197). Cambridge: Cambridge University Press. Doi: http://dx.doi.org/10.1017/CBO9780511545078.015



Participant ID#: ______________________
Rating date: ______________________
Rater ID: ______________________

Appendix A: MLSRI Instrument

MOTOR LEARNING STRATEGY RATING INSTRUMENT

Please rate the <u>extent to which</u> these strategies occur:	not at all	small	moderate	great	very great	Unable to rate
INSTRUCTIONS/FEEDBACK/CUES:						
1. Are provided	0	1	2	3	4	X
2. Are high in informational content	0	1	2	3	4	X
3. Direct attention externally	0	1	2	3	4	X
4. Direct attention internally	0	1	2	3	4	X
5. Involve 'asking' (rather than 'telling')	0	1	2	3	4	X
6. Address performance	0	1	2	3	4	X
7. Address results	0	1	2	3	4	X
8. Focus on what the child did correctly	0	1	2	3	4	X
9. Focus on what the child could do better	0	1	2	3	4	X
10. Link the task being practiced to another task or setting	0	1	2	3	4	X
CHILD VERBALIZATIONS:						
11. Are observed OR encouraged	0	1	2	3	4	X
12. Demonstrate thinking/problem-solving	0	1	2	3	4	X
13. Demonstrate teaching	0	1	2	3	4	X
PRACTICE IS:						
14. Active	0	1	2	3	4	X
15. Repetitive	0	1	2	3	4	X
16. Whole (rather than part)	0	1	2	3	4	X
17. Variable (rather than constant)	0	1	2	3	4	X
18. Challenging	0	1	2	3	4	X
19. Progressive	0	1	2	3	4	X

Please rate the extent to which these strategies occur:	not at all	small	moderate	great	very great	Unable to rate
THE SESSION INVOLVES:						
20. Modeling/demonstration	*0*	*1*	*2*	*3*	*4*	*X*
21. Physical guidance	*0*	*1*	*2*	*3*	*4*	*X*
22. Mental practice	*0*	*1*	*2*	*3*	*4*	*X*
WITHIN THE SESSION AS A WHOLE:						
23. Observation of the child's performance informs the therapist's actions/verbalizations	*0*	*1*	*2*	*3*	*4*	*X*
24. There are opportunities for the child to return to a previously practiced task	*0*	*1*	*2*	*3*	*4*	*X*
25. The therapist provides an environment where errors are a part of learning	*0*	*1*	*2*	*3*	*4*	*X*
26. The child is motivated by, or engaged in, the session	*0*	*1*	*2*	*3*	*4*	*X*
27. The therapist uses a variety of environmental resources	*0*	*1*	*2*	*3*	*4*	*X*
28. The child requires redirection from the therapist in order to stay on task	*0*	*1*	*2*	*3*	*4*	*X*
CARRY-OVER:						
29. The therapist recommends or encourages the child to practice tasks outside of therapy	***yes***			***no***		*X*
30. When a caregiver is present, the therapist provides training or education to that person	***yes***			***no***		*X*
WII/WIIFIT SPECIFIC:						
31. The child appears attentive or responsive to visual or auditory information provided by the Wii/WiiFit	*0*	*1*	*2*	*3*	*4*	*X*
32. The therapist uses the visual or auditory information provided by the Wii/WiiFit within the therapy session	*0*	*1*	*2*	*3*	*4*	*X*
33. The Wii/WiiFit is used with therapeutic intent	*0*	*1*	*2*	*3*	*4*	*X*

Participant ID#: __________	
Rating date: _____________	
Rater ID: ______________	

Appendix B: MLSRI Worksheet

MOTOR LEARNING STRATEGY RATING INSTRUMENT WORKSHEET

<table>
<tr><td colspan="3"><u>THERAPIST VERBALIZATIONS</u></td></tr>
<tr><td>Asks (specify)</td><td>vs</td><td>Tells</td></tr>
<tr><td>Internal</td><td>vs</td><td>External</td></tr>
<tr><td>Right</td><td>vs</td><td>Wrong</td></tr>
<tr><td>Performance</td><td>vs</td><td>Results</td></tr>
<tr><td colspan="2">Make links to similar/other tasks/settings (specify)</td><td>Provide education/training to caregiver</td></tr>
<tr><td colspan="2">Redirect child’s attention to task</td><td>Request practice outside of therapy time</td></tr>
<tr><td colspan="3">Provide non-informational encouragement, reinforcement, praise or criticism</td></tr>
</table>

<table>
<tr><td colspan="2"><u>CHILD VERBALIZATIONS</u></td></tr>
<tr><td>Teach therapist (specify)</td><td>Demonstrate thinking/problem-solving (specify)</td></tr>
<tr><td colspan="2">Relate to task/performance</td></tr>
</table>

<table>
<tr><td colspan="3"><u>PRACTICE</u></td></tr>
<tr><td>Part</td><td>vs</td><td>Whole</td></tr>
<tr><td>Same</td><td>vs</td><td>Varied</td></tr>
<tr><td>Challenging</td><td>and/or</td><td>Progressive</td></tr>
<tr><td>Mental practice (specify)</td><td><u>WII:</u> CHILD ATTENDS TO INFORMATION</td><td><u>WII:</u> THERAPEUTIC INTENT</td></tr>
</table>

NONVERBAL LEARNING Limits errors vs Encourages errors	
Demonstration/modeling is used	Hands-on guidance is used
OTHER	

Study ID#: ____________________________
Rating date: ___________________________
Rater ID: _____________________________

Please briefly describe the tasks involved in this session (and their start time). Clearly indicate task variations VERSUS new tasks.

Appendix C: Motor Learning Strategy Rating Instrument with item explanations

Please rate the extent to which this strategy occurred:	not at all	small	moderate	great	very great	unable to rate
INSTRUCTIONS/FEEDBACK/CUES:						
1. Are provided *How frequently is the therapist providing instructions, feedback or cues? This refers to all verbalizations, both informational and non-informational.*	***0***	***1***	***2***	***3***	***4***	***X***
2. Are high in informational content *'Informational content' refers to information that is directed towards learning. Non-informational instructions, feedback or cues are simply motivational praise, encouragement, reinforcement or criticism; for example 'great', 'good job', 'nice try', 'go', 'you can do better than that' etc.*	***0***	***1***	***2***	***3***	***4***	***X***
3. Direct attention externally *Instructions with an external focus of attention direct the learner towards the object or the effects of actions/movements on the environment. For example, "When you shoot the ball, concentrate on getting it in the net." In a balance task, it would direct the learner towards the support surface.* *If the focus of the instructions is the outcome or the environment, and there is no information about how the child should move to achieve that outcome, this is an external focus. The child doesn't need to think about what his/her body is doing or what the body actions are that are necessary to follow the instructions.* *Instructions to focus on 'quiet steps' are external.*	***0***	***1***	***2***	***3***	***4***	***X***
4. Direct attention internally *Instructions with an internal focus of attention direct the learner towards his/her own body movements, movement patterns, or actions. They usually refer to body parts. For example, "When you shoot the ball, concentrate on lifting your arms high and bending your knees" or "Turn those tummy muscles on!" In a balance task, it would direct the learner towards his/her feet.* *If the focus of the instructions is on something the child has to do with his/her body, for example the quality or type or the amount of movement of the body, this is an internal focus.*	***0***	***1***	***2***	***3***	***4***	***X***
5. Involve 'asking' rather than 'telling' *Verbalizations involve closed- or open-ended questioning directed towards learning through the use of questions that encourage the child to think/problem-solve about* ***the process of completing the task****. For example: "What do you think went wrong with that throw?" or "Do you think you arms are in the right place?". Questions that are for the purpose of 'checking-in' with the child as to their status at the moment (e.g. "Are you tired?" or "Do you want to do that again?") do not count. 'Telling' refers to a therapist who tells the child what to do or how to complete the movement or the task*	***0***	***1***	***2***	***3***	***4***	***X***
6. Address performance *Knowledge of performance* ***feedback*** *provides information about how the movement was performed:* ***movement nature or quality****. For example, "You didn't bend your knees enough when you jumped" and "Your arms are not moving fast enough when you are turning the rope."*	***0***	***1***	***2***	***3***	***4***	***X***

7. Address results *Knowledge of results* ***feedback*** *is information relating to the* ***achievement of the goal or action****. For example, "Your throw missed the net by two feet".*	***0***	***1***	***2***	***3***	***4***		***X***
8. Focus on what the child did correctly ***Feedback*** *that provides specific information related to* ***successful*** *movements/results. For example, "I really liked how you took a nice long step that time."*	***0***	***1***	***2***	***3***	***4***		***X***
9. Focus on what the child could do better ***Feedback*** *provides specific information related to* ***unsuccessful*** *movements/results with or without suggesting ways in which the child could improve movements/results. For example, "You are shrinking down instead of standing tall."*	***0***	***1***	***2***	***3***	***4***		***X***
10. Link the task being practiced to another task or setting *Does the therapist make comparisons or links to a similar task or to the same task in a different setting when discussing the task or when providing instructions or feedback. For example, "this is just like when you have to step over a sidewalk curb." N.B. the task must be a realistic one.*	***0***	***1***	***2***	***3***	***4***		***X***
CHILD VERBALIZATIONS:							
11. Are observed OR encouraged *Extent to which the child verbalizes about performance or results of the task or about the nature of the task itself. If the therapist is encouraging the child to verbalize but the child is not participating, this is also appropriate to rate. For example,. "This is really hard"; "I'm really happy that I did that well". If the child is not talking about the task/performance but is talking about something unrelated, this should not be considered for rating.*	***0***	***1***	***2***	***3***	***4***		***X***
12. Demonstrate problem-solving *Indicators include: the child is working out a solution to the problem, the child sorting through a number of options, the child comparing performance/results of one trial to another trial, the child is questioning the therapist about aspects of the activity, etc. For example, "This is harder than it was last time"; "I think I am having an easier time throwing because the ball is lighter"; "Why are the beanbags so far apart? It would be easier if they were closer together."*	***0***	***1***	***2***	***3***	***4***		***X***
13. Demonstrate teaching *Does the child instruct the therapist in the* ***process*** *of undertaking the task? This is different from a child who is simply providing a minor correction or clarification for the therapist, which should not be rated. For example, if the child takes the wiimote from the therapist and just presses a button, this doesn't count. (N.B. It is acceptable for this behaviour/verbalization to be prompted or initiated by the therapist).*	***0***	***1***	***2***	***3***	***4***		***X***
PRACTICE IS:							
14. Active *The child is physically OR cognitively engaged in therapy. Do not consider what is happening during rest periods or indicators of child physical exertion (e.g. fatigue) when rating this item. Passive practice would mean that the child was neither physically (e.g. movement) or cognitively (e.g. verbalizing or problem-solving) engaged in therapy. If therapist is encouraging physical or cognitive activity but the child is not participating, this is also appropriate to rate.*	***0***	***1***	***2***	***3***	***4***		***X***

15. Repetitive *There are numerous repetitions of each task.*	*0*	*1*	*2*	*3*	*4*		*X*
16. Whole (rather than part) *Tasks are practiced in their entirety rather than broken up into component parts. For example, walking (whole) vs weight-shifting or stepping (part).* *Playing a Wii game is a whole task. However, if the therapist works on parts of the skill necessary for the game (eg quality of weight-shifting) and then puts it back together to play the game again, this would be considered part to whole practice.*	*0*	*1*	*2*	*3*	*4*		*X*
17. Variable (rather than constant) *The same task is varied over repetitions (for example: throwing a beanbag, throwing a basketball, changing the height of the net in which the ball is thrown) rather than practicing the same task repeatedly without changing it at all (constant).* *By itself, a Wii game cannot be variable if the same game is practiced over repetitions. However the therapist can make the practice variable by changing the position the child is in to play the game or adapting things in other ways.*	*0*	*1*	*2*	*3*	*4*		*X*
18. Challenging *Observation that the child is unable/having difficulty with completing desired task quantity or quality and that there is room to learn to be more successful at the task. An unchallenging task would appear easy for the child to complete successfully with no apparent room for greater learning. This involves observation of the child with respect to quality of movement, movement effort, movement speed, etc.* *Assume that most PT sessions are at least a little challenging. So a baseline level of challenge would be a 0.* *For the Wii components, you can judge challenge based on information that you see about whether or not the child is successful at the game, but more likely, you will have evidence of whether or not the child is successful at the therapy task that the therapist is using the Wii game for (e.g. is it easy to stand on one leg, is is really challenging for the child to bowl while on the bosu ball, etc).*	*0*	*1*	*2*	*3*	*4*		*X*
19. Progressive *Complexity is progressed during practice of each task. Complexity refers to: amount or type of physical or cognitive challenges, number of components, difficulty level, etc.* *It may be difficult to judge whether the wii game itself is progressive if you don't know whether or not the child is going up a level in difficulty. If the therapist verbalizes that the next game is harder, that would be an indication of progression. The therapist could also progress by adding more therapy elements to the Wii task (like bosu ball, weights etc).*	*0*	*1*	*2*	*3*	*4*		*X*

THE SESSION INVOLVES:							
20. Modeling/demonstration *The therapist physically demonstrates or models skills/tasks for the child during the therapy session.*	*0*	*1*	*2*	*3*	*4*		*X*

21. Physical guidance *This is guidance (including facilitation or inhibition) that is for the purpose of performing or learning the task, NOT for the purpose of keeping the child safe/preventing falls, etc.*	0	1	2	3	4		X
22. Mental practice *Mental practice is the act of performing the skill in one's imagination with no action involved. The therapist encourages the child to use mental practice or the child initiates and verbalizes that he/she is using mental practice. For example, "Before we start, I want you to close your eyes and picture in your mind what a good jump looks like." N.B. This must not occur during physical practice.*	0	1	2	3	4		X

WITHIN THE THERAPY SESSION AS A WHOLE:							
23. Observation of the child's performance informs the therapist's actions/verbalizations *The child's behavior is monitored and the session or task is modified when appropriate. Does therapist behaviour relate to what she is seeing in the child; is it influenced by the child's performance/results? For example, is the therapist changing task difficulty levels based on what she is seeing? Do the therapist's verbalizations relate to what she is seeing?* *To help you rate this item, look at your scores for challenging and progressive and whether there is evidence of different strategies being used in the instructions section.*	0	1	2	3	4		X
24. There are opportunities for the child to return to a previously practiced task *This item is not the same as # 15. Rather, the question is whether or not the therapist* ***returns to a task after practicing other tasks****. For example, does the therapist practice a few variations of a task and then come back to the first variation? Or, does the therapist practice a few different tasks and then come back to one of those tasks? As long as there is at least one variation of a task/new task practiced before the old task/variation is returned to, this should be rated. This gives the child the chance to retrieve the task solution from memory.*	0	1	2	3	4		X
25. The therapist provides an environment where errors are a part of learning *The therapist chooses and structures tasks in ways that allow the child to make errors. The therapist does not use physical guidance to prevent errors from happening. The therapist increases the difficulty of a task if it appears too easy for the child. (N.B. The therapist may or may not verbalize about the errors.)*	0	1	2	3	4		X
26. The child appears motivated by, or engaged in, the therapy session *Indicators of motivation or engagement include observations of child affect such as laughing, verbalizing, having fun, OR appears to be concentrating on therapy activities OR appears invested in therapy participation.*	0	1	2	3	4		X
27. The therapist uses a variety of environmental resources *Environmental resources include people OR objects OR settings. If the therapist is using only one object (e.g beanbags or the bosu ball), are they varying ways in which the object is being used? Is the therapist involving the caregiver in the therapy session? Is the therapy session taking place in a variety of settings (e.g. hallway, stairs, isolated therapy room, etc).*	0	1	2	3	4		X

28. The child requires redirection from the therapist in order to stay on task. *The child's behaviour OR attentional OR cognitive issues require the therapist to verbally or physically redirect the child's attention to the task(s) at hand.*	*0*	*1*	*2*	*3*	*4*	*X*

CARRY-OVER:						
29.The therapist recommends or encourages the child to practice tasks outside of therapy time *Does the therapist verbalize that she would like the child to continue to practice a task outside of therapy time?*	*yes*			*no*		*X*
30. When a caregiver is present, the therapist provides training or education to that person *Education or training refers to providing information about the child's condition, his/her immediate task performance, or instructions/training about how to undertake a task with the child outside of therapy. If no caregiver is present, you are unable to rate this item.*	*yes*			*no*		*X*

WII/WIIFIT SPECIFIC:						
31. The child appears attentive or responsive to visual or auditory information provided by the Wii/WiiFit *The child laughs, comments on, reacts to, appears distressed by, concentrates on, etc the Wii/WiiFit. Can include what you perceive to be positive or negative reactions.*	*0*	*1*	*2*	*3*	*4*	*X*
32. The therapist uses the visual or auditory information provided by the Wii/WiiFit within the therapy session *The therapist verbally or physically draws the child's attention to this information OR incorporates this information within the therapy session. This is different from a therapist who is simply engaged in the Wii task.*	*0*	*1*	*2*	*3*	*4*	*X*
33. The Wii/WiiFit is used with therapeutic intent *A therapist who scored high on the previous item would also score high on this item. Alternatively, a therapist who scored low on the previous item could be scored highly on this item if the child is being physically challenged by the task; i.e. that the Wii task is targeting the child's therapeutic needs. Non-therapeutic use would consist of use as a simple 'fun reward' with no clear physical or cognitive challenge, in which the therapist was not present or engaged in the Wii practice.*	*0*	*1*	*2*	*3*	*4*	*X*

Appendix D: MLSRI Scoring Rules

1. It should take you a maximum of approximately 2X the duration of the video (i.e. if the video is 30min long, it should take you no longer than 60min) to complete the worksheet and scale.

Please write down all therapist 'asking' verbalizations verbatim on the worksheet. Please indicate which you used in your rating of the scale (i.e. cross out the ones that you wrote down in order to think about more and didn't end up using).

2. Task = a set of skills having an end point or a specific outcome. Skills include (but are not limited to): throwing, kicking, catching, running, jumping, hopping, walking, etc. Sometimes practice may be simply a skill and not a task; that is fine, consider it a task.

3. When deciding whether something is a variation on a task or a new task, always ask yourself: What is the underlying skill that seems to be central to this task? Be specific with regards to what you are seeing: a skill is not 'balance', 'strengthening', or 'endurance'. Variations on a skill can include changing equipment or adding new skills to the central skill. On the other hand, changing equipment or adding new skills could also imply a new task, depending on what you judge to be the central skill. Take into consideration the context and the focus of the therapist's verbalizations when deciding upon the central skill in the task. This involves some judgement, but if everyone asks themselves the same question and doesn't judge too broadly as to the central skill then it should be fine.

For each task, ask yourself:

Is the task being repeated?
If yes….

Are the repetitions variable?
If yes…..

Are the variations progressive?
Yes or no

Is the task challenging?
Yes or no

4. Part or whole task practice: Many part tasks will be obvious parts of a whole (e.g. weight-shifting - walking; squatting - sit to stand). In other cases, it is important to hear the therapist verbalize that parts are being practiced in order to put them together into a whole. Do not **assume** that the last variation of a task was the 'whole' and the previous variations were 'parts' unless the therapist has verbalized this.
    - If you see practice of a part task and subsequently practice of a whole task: this is progressive and variable

5. Please remember to note the time each NEW task begins. After watching the session as a whole, please indicate on the second page of the worksheet what you consider to be variations on a task versus new tasks.

6. If a therapist is verbally counting the number of repetitions during a task, we define this as providing knowledge of results feedback.

7. If a therapist says 'so close' when referring to the outcome of a task, we define this as providing knowledge of results feedback.

8. If the task involves the therapist participating and doing the same skill/action that is required of the child, in a way that the child can observe them doing it, include this under 'demonstration/modeling'.

9. Verbalizations are instructions when they **precede** a first or subsequent attempt at the task. Instructions can be rated as:

    - Asking vs telling

- Internal vs external focus of attention

10. Verbalizations are feedback when they refer to a task that has just been attempted. Feedback can rated as:
    - Asking vs telling
    - Performance vs results
    - Right vs wrong

11. 'Right' and 'wrong' – the therapist needs to be **specific** about what the child is doing rightly or wrongly. Try not to assume that just because the PT is repeating feedback that it is because the child is doing something wrong, unless the PT verbalizes this.

12. If you're not entirely sure, score down.

13. Different games on the Wii are different tasks.

14. If the child verbally teaches the therapist regarding the process of how to set up the Wii task, this should be rated under 'teaching'.

Please write down all 'teaching' verbalizations verbatim on the worksheet. Please indicate which you used in your rating of the scale (i.e. cross out the ones that you wrote down in order to think about more and didn't end up using).

15. Not all therapist verbalizations require rating. For example, a therapist can provide general information about a task before it begins to set up the task or to provide the child with **general** knowledge about the task (e.g In this game you will be hopping on one leg over the pylon, the pylons are about 1 foot apart). This does not require rating. However, if the therapist is giving **child-specific instructions**, this is rated.

16. If there is verbalization of any sort about **goals**, please note this under 'other' on the worksheet.

17. In order for therapist verbalizations to be rated under 'links the activity being practiced to another activity or setting', the other activity or setting must be realistic, NOT a fantasy activity or setting. The therapist can link to another activity practiced within therapy OR to an activity that is outside of therapy.

Please write down all 'linking' verbalizations verbatim on the worksheet. Please indicate which you used in your rating of the scale (i.e. cross out the ones that you wrote down in order to think about more and didn't end up using).

Please write down all **child** verbalizations that you consider to demonstrate 'thinking/problem-solving' verbatim. **Please indicate which you used in your rating of the scale (i.e. cross out the ones that you wrote down in order to think about more and didn't end up using).**

Verbalizations - Imagination and fantasy

1. When a therapist uses the words 'pretend' or 'imagine', this might be rated under 'links to another activity or setting' ONLY if the pretending/imagining relates to a real-world situation. E.g. "pretend like you are walking fast because you need to cross the street."

See above re: writing down 'linking' verbalizations.

2. It could also relate to mental practice. E.g. "Before we start, close your eyes and imagine yourself doing a really good jump/imagine what really good jump looks like."

Please write down all mental practice instructions verbatim on the worksheet. Please indicate which you used in your rating of the scale (i.e. cross out the ones that you wrote down in order to think about more and didn't end up using).

3. Or, it could just involve creating the context for a play situation during therapy, and not have to do with learning at all. E.g. "Let's pretend that we are on a ship in the middle of the ocean."

Appendix E: McMaster University Research Ethics Form

Hamilton Health Sciences

RESEARCH ETHICS BOARD

REB Office, 1057 Main St. W., Hamilton, ON L8S 1B7
Telephone: 905-521-2100, Ext. 42013
Fax: 905-577-8378

McMaster University

April 23, 2009

PROJECT NUMBER: 09-163

PROJECT TITLE: Understanding the use of interactive video games within physiotherapy interventions for children and youth with acquired brain injury.

PRINCIPAL INVESTIGATOR: Dr. Cheryl Missiuna

As you are aware your study was presented at the April 21, 2009 Research Ethics Board meeting where it received ***provisional*** approval from the full Research Ethics Board. The REB has identified the following issues/revisions:

- Add a version number to the consents.
- Add the sponsor name to the first page of the consents.
- Change "Witness" to "Person Obtaining consent" to the Parent and Physiotherapists consent.
- Add print, sign, and date lines on the last page of all of the consents.

Please note your revised submission should include a cover letter, which addresses each of the bullets identified in this letter, and the revisions should be ***clearly*** highlighted in each revised document. When sending in revised consent forms please include 2 clean copies (no highlighting). Upon receipt of the revised submission, final approval will be forthcoming.

Investigators in the Project should be aware that they are responsible for ensuring that a complete consent form is inserted in the patient's health record. In the case of invasive or otherwise risky research, the investigator might consider the advisability of keeping personal copies.

A condition of approval is that the physician most responsible for the care of the patient is informed that the patient has agreed to enter the study.

PLEASE QUOTE THE ABOVE-REFERENCE PROJECT NUMBER ON ALL FUTURE CORRESTPONDENCE

Sincerely,

Jack Holland, MD, FRCP, FRCP (C)
Chair, Research Ethics Board
/cg

Appendix F: Holland Bloorview Kids Rehabilitation Centre Research Ethics Form

Bloorview
KIDS REHAB

Bloorview Kids Rehab
150 Kilgour Road
Toronto ON Canada M4G 1R8
Tel: 416 425 6220
Toll-Free: 800 363 2440
Fax: 416 425 6591
www.bloorview.ca
A teaching hospital fully affiliated with the University of Toronto

Bloorview Research Ethics Board
Ethics Approval Notification

The Bloorview Kids Research Ethics Board operates in compliance with the Tri-Council Policy Statement Ethical Conduct for Research Involving Humans, the Ontario Personal Health Information Protection Act, 2004, ICH Good Clinical Practice Consolidated Guideline E6, and Health Canada Part C Division 5 of the Food and Drug Regulations

Study Title: Exploring the use of Nintendo Wii and WiiFit virtual reality games within physiotherapy interventions for children and youth with acquired brain injury
File number: 09-012
Principal Investigator: Virginia Wright
Co-Investigators: Danielle Levac, Cheryl Missiuna, Laure Wishart, Carol DeMatteo, Patricia Miller
Original Approval Date: May 25, 2009
Expiry Date: May 25, 2010
Timeframe of Study: August 2009 to May 2010

May 25, 2009

Dear Virginia Wright,

The Bloorview Research Ethics Board (REB) has reviewed the above named study and is granting ethics approval for a period of one year ending May 25, 2010. The approval of this study includes the following documents:

- Protocol, TAHSN & Appendices A through I (received May 25, 2009)

This study must be conducted in accordance with the description in the application and any supplementary documents for which ethics approval has been granted. Any changes need be submitted through an "Amendment Form" to the REB for approval *before* the changes are implemented, except where necessary to eliminate immediate hazards to the participants.

Any adverse events that occur as a result of your study must be reported to the REB by submitting an "Adverse Event Form".

Upon completion or termination of your study, you need to submit a "Research Completion Form". Should your study continue for more than one year you must request a renewal, three weeks prior to the expiry date, by submitting an "Annual Renewal Form".

Please ensure that the original *signed* consent forms are sent to Health Data Resources to be filed with the client's file.

Best wishes for the successful completion of your project.

Sincerely,

[redacted]

Doug Biggar
Chair, Research Ethics Board
Professor of Pediatrics
Tel: (416) 424-3813

Page 1 of 1

From disability to possibility

Appendix G: Information Sheets and Consent Forms

REB#_____________
Client Name: ____________

Wii/ WiiFit & Physiotherapy Study
Bloorview Kids Rehab & McMaster University

Script for RA to provide information to children, teenagers and parents about the study

(NB – the RA may be speaking to just the parent, to both parent and child, or to just teenager and will change her use of pronouns accordingly. She may also be speaking on the phone or in person)

Project: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury.

Investigators: Dr. Virginia Wright, Bloorview Kids Rehab
Danielle Levac, PhD Candidate, Dr. Cheryl Missiuna, Carol DeMatteo, Dr. Laurie Wishart, Dr. Pat Miller, McMaster University

Participant information **Date:**__________
Participant name: ____
Parent/Guardian Name: ____
Contact phone number: ____

Hello, my name is [insert RA's name] and I am a Research Assistant at Bloorview Kids Rehab. Recently, [insert name of physiotherapist] at Bloorview Kids Rehab spoke to you about a research project we are doing and mentioned that you had agreed to be contacted to hear more. Are you still interested in hearing about this project?

IF NO, Would there be a better time for me to [call/drop by]?
IF STILL NO, That's fine. I will not contact you again. Thank you for your time.

IF YES, Great!

Let me tell you more about the study. Please stop me at any time if you have a question. We are doing a study to understand the use of the Nintendo Wii and WiiFit interactive video games within physiotherapy treatments. We would like to understand the similarities and differences between physiotherapy treatment that uses these games and treatment that does not use these games.

Let me tell you what the study would require of you and your child. If you and your child agree to be in this study, we will videotape two of his/her physiotherapy sessions. We will watch the tapes to compare activities that use the Wii/WiiFit and those that do not use the Wii/WiiFit. No-one else will see the videotapes. They will be kept very secure. We will also ask you to fill out a short questionnaire to give us some information about your child, such as their age and grade.

There is no known risk from videotaping your child's physiotherapy session. There are also no benefits. Please realize that your decision to participate, or not, will not have any impact on your child's treatment by Bloorview Kids Rehab. You and your child's participation in the study is completely voluntary.

Do you have any questions at this point? Are you still interested in participating in our study?

IF NO: That's fine. I will not contact you again. Thank you for your time.

Follow up process if parent says yes:

IF YES: I will give you an information and consent letter for you and a letter for your child. You will have some time to read the letters to decide if you would still like to participate, and to ask us any questions that you may have. I can also go over the study's consent form and assent form with you and your child if you would like. If you read the consent and decide not to participate, please just let us know. This is not a problem! If you would like to participate, we will ask both you and your child to sign indicating that you understand and agree to participate in the study.

Follow-up process if youth (16+) says yes:

IF YES: I will give you an information letter for you to read. The first step is to read over and sign this consent form. The consent form gives you information about the study. You can sign after you have had the chance to ask us any questions you might have. If you receive the consent form, read it over and decide not to participate, please just let us know. This is not a problem! I will also give an information form to your parent(s) to read. This is a form that explains the study to them. There is a support form that they can sign and bring back to us indicating that they understand and support your participation in the study.

Is there a good time in the next few days for me to call/drop by to go over the information package with you?

_______________________ *(record date/time)*

Thank you for your time. I look forward to speaking with you again soon.

____ ___________________________

Research Assistant's Signature **Date**

Bloorview KIDS REHAB | McMaster University

REB #.____________
Client Name: ____________

INFORMATION LETTER FOR PARENTS
Wii / WiiFit & Physiotherapy Study
Bloorview Kids Rehab & McMaster University

April 2009

Project: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury.

Investigators: Virginia Wright - Bloorview Kids Rehab, Danielle Levac (PhD Candidate), Cheryl Missiuna, Carol DeMatteo, Laurie Wishart, Pat Miller - McMaster University
Sponsor: Physiotherapy Foundation of Canada

Dear Parents/Guardians,

We would like to invite your child to be in a research study. We are studying how Nintendo Wii and WiiFit video games are used during physiotherapy for children and youth who have an acquired brain injury (ABI). Before agreeing to be in this study, it is important that you understand the study and how you and your child will be involved. **Choosing to participate or not in this study will not affect your child's care and treatment.**

WHAT IS THE STUDY ABOUT?

The Nintendo Wii and WiiFit are popular video games that are being used to help children who have had an ABI to relearn balance and movement skills. Physiotherapists at Bloorview Kids Rehab use these video games as part of their treatments. To understand more about how and why the Wii/WiiFit is used, we will watch its use during physiotherapy sessions, and we will talk to the physiotherapists about its use.

HOW WILL MY CHILD AND I BE INVOLVED IN THE STUDY?

We will enroll 12 children and youth from Bloorview Kids Rehab in this study. Your child's physiotherapist has already decided that the Wii/WiiFit is a tool that she will likely use in treatment. If you and your child agree to take part in this study, we will ask you to fill out a short questionnaire about your child including his/her age, grade at school, and information about his or her past medical history. Physiotherapists will also be asked to fill out a short questionnaire with information relevant to individual children's physiotherapy treatment, including the cause of ABI and scores on standardized assessments, such as the Community Balance and Mobility Scale.

A research assistant will videotape two physiotherapy treatment sessions during your child's stay at Bloorview Kids Rehab. These treatment sessions will occur about two weeks apart. This will give us a good idea of how the Wii/WiiFit is being used with your child. The research assistant will edit your child's videotape so that it shows all of the activities in which the Wii/WiiFit was used, as well as some of the other activities that are done in the rest of the treatment session. Your child's videotape will be kept in a locked cabinet. The research assistant will make the videotape into an MPEG movie file so it can be watched on a computer. The MPEG movie will be put onto a password protected and encrypted memory stick. The memory stick with the MPEG movie will be transferred by secure courier to McMaster University. A member of the research team will watch it at McMaster University in a private space so that others cannot see the screen. The memory stick will also be kept in a locked cabinet. Your child's name will not be heard at any time in the movie that we make. At the beginning of the movie, there will be a 20 second written message indicating the use of this video is only for the Wii/WiiFit study. At the end of the study, your child's physiotherapist will take part in an interview about how and why she made decisions to use the Wii/WiiFit in her physiotherapy treatment sessions.

WHAT ARE THE BENEFITS TO ME OR MY CHILD?

You and your child may not immediately benefit from this research. Being in the study will not affect your child's physiotherapy treatment in any way. Your child's physiotherapist will choose all of the therapy activities that are done with and without the Wii/WiiFit. Your child will receive a $5 Tim Horton's gift certificate as a token of appreciation for being in the study.

WHAT RISKS ARE INVOLVED IN THIS STUDY?

The risks of falling or muscle injury to your child are the same as those in any physiotherapy session in which the Wii/WiiFit is used. Your child's physiotherapist will take all normal safety precautions to guard your child from these risks. It is possible that your child might be nervous about being videotaped during physiotherapy. We will tell your child that the only people who will see these tapes are the researchers in the study.

DO I HAVE TO DO THIS?

Choosing to participate or not in this study will not affect your child's care and treatment. If you and your child decide to take part, but either of you changes your mind at any time, that is fine. This will not affect the services you or your child gets from Bloorview Kids Rehab. There is no obligation to participate in any part of this project.

WHAT ELSE DO I NEED TO KNOW?

All the information we collect about your child is confidential. Only the researchers will have access to the data. If the results of the study are published, your child's name will not be used and no information that discloses his/her identity will be released or published without your specific consent to the disclosure.

This study has been reviewed by the Bloorview Kids Rehab Research Ethics Committee and the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board. If you have any questions about your rights as a research participant, you may contact the Office of the Chair of the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board at 905-521-2100, Ext. 42013. At Bloorview Kids Rehab, you may contact the Research Ethics Board Coordinator at 416-424-6200, Ext. 3507.

If you would like more information about the study at any time, please contact the researcher, Danielle Levac at 905-525-9140, Ext. 21458 or by email at levacde@mcmaster.ca. You can also contact Virginia Wright at 416-424-3824 or by email at vwright@bloorview.ca.

WHAT IF I HAVE QUESTIONS?

Please ask either of us to explain anything you don't understand before signing the consent form. If you leave a voicemail message, we will return your call within 48 hours. Thank you for thinking about helping us with this project.

Yours truly,

Danielle Levac, PT, MSc., PhD Candidate
McMaster University
Phone: 905-525-9140 ext 21458
levacde@mcmaster.ca

Virginia Wright, PT, PhD
Bloorview Kids Rehab
Phone: 416-424-3824
vwright@bloorview.ca

Bloorview KIDS REHAB | McMaster University

REB#____________
Client Name: ____________

CONSENT FORM FOR PARENTS
Wii / WiiFit & Physiotherapy Study
Bloorview Kids Rehab & McMaster University

Re: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury.

Please complete this form and return it to a study investigator.

A research investigator has explained this study to me. I read the Information Letter dated April 2009 and I understand what this study is about. I understand that my child or I may drop out of the study at any time.

I agree to participate in this study and to allow my child to participate.

______________________________ ______________________________ __________

Parent's Name (please print) Signature Date

______________________________ ______________________________ __________

Person Obtaining Consent (print) Signature Date

Bloorview KIDS REHAB McMaster University

REB #.____________
Therapist Name: __________

INFORMATION LETTER FOR PHYSIOTHERAPISTS
Wii & WiiFit and Physiotherapy Study
Bloorview Kids Rehab & McMaster University

April 2009

Project: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury.

Investigators: Virginia Wright - Bloorview Kids Rehab, Danielle Levac (PhD Candidate), Cheryl Missiuna, Carol DeMatteo, Laurie Wishart, Pat Miller - McMaster University
Sponsor: Physiotherapy Foundation of Canada

Dear Therapists,
You are being invited to participate in a research project because you are a physiotherapist in the Neurorehabilitation program at Bloorview Kids Rehab (BKR). To help you decide whether or not you want to be a part of the research, you should understand what the study involves, and the potential risks and benefits. You will have the opportunity to ask questions of the study investigators. Once your questions have been answered, you will be asked to sign this form to indicate that you are willing to participate in this study. **Choosing to participate or not in this study will in no way affect your employment at BKR.**

WHAT IS THE STUDY ABOUT?
The Nintendo Wii and WiiFit are interactive video games that are being used in rehabilitation settings, including BKR. We are interested in how and why physiotherapists working with children and youth with ABI use the Wii/WiiFit in their interventions. We would also like to know your thoughts when it comes to using these games in your therapy sessions. Lastly, in order to understand how using these games is similar or different from other types of activities in physiotherapy, we are interested in knowing more about what kinds of activities are involved in 'usual' physiotherapy intervention sessions for this population.

WHAT WILL BE MY RESPONSIBILITIES IF I TAKE PART IN THE STUDY?
If you are willing to be in this study, we will ask you to help the research assistant (RA) involved with the study by making the initial contact with up to three of your patients. We will ask you to let the RA know when there is a patient with whom you plan to use the Wii/WiiFit with during your interventions. You will then ask the parents of your eligible patients and/or the patient him/herself (depending on age) the following question: "We have a research study in the Neurorehabilitation program that looks at understanding the use of Nintendo Wii/Wii fit videogames within physiotherapy interventions for children and youth with brain injuries. Would it be okay if I asked the research assistant with the study to talk to you about it, in person or over the phone? May I pass your phone number on to the research assistant?" If they agree, we ask you to let the RA know and provide her with the phone number as soon as possible. The RA will then speak to the client and his/her family to give them more information and ask them if they would like to be part of the study.

If the patient and his/her family agree to participate, we will videotape two of your intervention sessions with the child. These will be sessions at least two weeks apart. The videotaping will not influence your treatment in any way. You are free to make decisions about the types and length of activities that you will do in your session. The only requirement is that you use the Wii/WiiFit at some point within each intervention session. The RA who will videotape the interventions is not a physiotherapist. After each session, we will ask you to complete a short log describing your goals during that session and rating the child's engagement and attention. This will take you no more than a few minutes.

We will also ask you to complete two short forms – one with information about you as a therapist (which will not be linked to any other study data) which you will only need to complete once. A second form asking for demographic information about your client will need to be completed once for each child. At the end of the study period, we will invite you to take part in a tape-recorded interview with Danielle Levac, scheduled at a convenient time for you. We will ask you to tell us about your thoughts about using the Wii/WiiFit in your physiotherapy interventions.

DO I HAVE TO DO THIS?
If you agree to participate in the study, your participation is voluntary and you may decide to withdraw from the study at any time. There is no obligation to participate in any aspect of this project.

WHAT ARE THE RISKS AND BENEFITS TO ME?
As far as we know, there are no risks. Your professional practice leader will not see the videotapes and they will not be used for performance appraisals in any way. There are no direct benefits to being in the study. You will have the opportunity to reflect and give your opinions and perspectives on the use of the Wii/WiiFit in physiotherapy. You do not need to answer any question you do not wish to, and you can pause or stop the interview at any time.

WHAT INFORMATION WILL BE KEPT PRIVATE?
If the results of the study are published, your name will not be used and no information that discloses your identity will be released. Videotapes of your interventions and audiotapes/transcripts of interviews with you will not be heard or seen by anyone outside the research team. You may have a copy of the transcription of your interview if you wish. Your tape recorded interview will be transcribed into a Word document in which your name will not appear.

The research assistant will make the videotape into an MPEG video. At the beginning of the video, there will be a 20 second written message indicating the use of this video is only for the Wii/WiiFit study. The original videotape of your physiotherapy sessions will be kept in a locked cabinet. The research assistant will make this videotape into an MPEG file so it can be watched on a computer. The MPEG file will be put onto a password protected and encrypted memory stick which will be transferred by secure courier to McMaster University. A member of the research team will watch it at McMaster University in a private space so that others cannot see the screen. The memory stick will also be kept in a locked cabinet.

WILL I BE PAID TO PARTICIPATE IN THE STUDY?
The two videotaped sessions will be part of your usual paid working hours. BKR will reimburse you for the interview time. The interview will be 1 to 1.5 hours in length and will require no preparation beforehand. The time that you spend in the interview will be reimbursed by the study at your regular rate of pay and you will bill the time through your bi-weekly paycard.

WHAT ELSE DO I NEED TO KNOW?
This study has been reviewed by the Bloorview Kids Rehab Research Ethics Committee and the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board. If you have any questions about your rights as a research participant you may contact the Office of the Chair of the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board at 905-521-2100, Ext. 42013. At Bloorview Kids Rehab, you may contact the Research Ethics Board Coordinator at 416-424-6200, Ext. 3507.

If you would like to receive more information about the study at any time, please contact me at 905-525-9140, Ext. 21458 or by email at levacde@mcmaster.ca. You can also contact Virginia Wright at 416-424-3824.

WHAT IF I HAVE QUESTIONS?
Please ask us to explain anything you don't understand before signing the consent form. If you leave me a message, we will return your call within 48 hours.

Thank you for thinking about helping us with this project.

Yours truly,

Danielle Levac, PT, MSc., PhD Candidate
McMaster University
Phone: 905-525-9140 ext 21458
levacde@mcmaster.ca

Virginia Wright, PT, PhD
Bloorview Kids Rehab
Phone: 416-424-3824
vwright@bloorview.ca

Bloorview KIDS REHAB McMaster University

REB#_____________
Therapist Name: _____________

CONSENT FORM FOR PHYSIOTHERAPISTS
Wii & WiiFit and Physiotherapy Study
Bloorview Kids Rehab & McMaster University

Re: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury.

Please complete this form and return it to a study investigator.

I have read the information letter dated April 2009 and I have had the opportunity to ask research investigators any questions that I have. I understand what this study is about and that I may drop out of the study at any time.

I agree to participate in this study.

______________________	____________________	________
Therapist's Name (please print)	Signature	Date
______________________	____________________	________
Person Obtaining Consent (print)	Signature	Date

Bloorview KIDS REHAB McMaster University

REB#____________
Client Name: ____________

INFORMATION SHEET FOR CHILDREN AGE 7-15 YEARS
Wii / WiiFit and Physiotherapy Study
Bloorview Kids Rehab & McMaster University

April 2009

Using video games during physiotherapy treatment

You are being invited to take part in a research study. A research study is a way to learn more about people. Here is some information about the study.

WHY ARE WE DOING THIS STUDY?
We are doing a study to understand how physiotherapists use Nintendo Wii and WiiFit games when they work with kids and teens. Since these games have only just started to be used in physiotherapy, it is important to understand more about how they are being used and why they might help.

WHY AM I BEING ASKED TO BE IN THIS STUDY?
We are inviting kids and teens with a brain injury who are receiving physiotherapy to be in the study.

IF I AM IN THE STUDY WHAT WILL HAPPEN TO ME?
If you and your parents decide that you want to be in this study, we will videotape the things that you and your physiotherapist do during two different physiotherapy treatments. These treatments will happen about 2 weeks apart. The person who will videotape you is a research assistant. She will not tell you or your physiotherapist what to do, and she will not get in your way during your physiotherapy.

Another person will watch the videotapes to see what activities you did with the Wii/WiiFit and the other activities you did in your session. We will also ask your physiotherapist to talk to us about how and why she used the Wii/WiiFit.

WHAT WILL I GET OUT OF BEING IN THE STUDY?
The study will help us to understand more about how physiotherapists can use the Nintendo Wii/WiiFit in physiotherapy to help kids learn movement and balance skills.

WILL I BE HURT IF I AM IN THE STUDY?
Since you are already using the Wii/WiiFit as part of your therapy, we don’t think that there are extra risks to being in this study. You may be nervous to have someone

videotape what you do during physiotherapy. If you would like, you can look through the camera lens to see what the camera sees. The only people who will see the videotapes are the researchers involved in this study.

WILL ANYONE KNOW THAT I DID THIS STUDY?
Only the people who are involved with the study will see your videotapes. We will keep the videotapes locked up. When we are finished with this study we will write a report about what we learned. This report will not include your name or that you were in the study.

DO I HAVE TO DO THIS?
If you do not want to be in this study, that's O.K. You can tell your parents or me that you don't want to be in it. This will not affect how your therapist will treat you. If you say yes now, you can change your mind later. That is O.K. too.

WHAT IF I HAVE QUESTIONS?
You can ask questions if you do not understand any part of the study. If you have questions later, you can ask your parents to call Danielle, the study investigator, again at 905-525-9140, ext 21458.

WHAT IF I AM NOT SURE?
Your parents know about this study. You can ask them questions if you don't understand what this is about. You can also ask me more about the study before you decide whether or not you want to be involved.

Danielle Levac, PT, MSc., PhD Candidate
McMaster University
Phone: 905-525-9140 ext 21458 email: levacde@mcmaster.ca

Virginia Wright, PT, PhD
Bloorview Kids Rehab
Phone: 416-424-3824 vwright@bloorview.ca

Bloorview KIDS REHAB | McMaster University

REB #____________
Client Name: ____________

ASSENT FORM FOR CHILDREN AGED 7-15 YEARS
Wii / WiiFit and Physiotherapy Study
Bloorview Kids Rehab & McMaster University

Using video games in physiotherapy treatment

I want to be in this study.

____________________________ ____________
Name of participant Age

____
Signature

I read this form to ____ and they agreed to participate.

____
Name of Person Who Obtained Assent

____
Signature

____
Date

Bloorview KIDS REHAB McMaster University

REB #.____________
Client Name: ____________

INFORMATION LETTER FOR YOUTH AGE 16-18
Wii / WiiFit & Physiotherapy Study
Bloorview Kids Rehab & McMaster University

April 2009

Project: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury.

Investigators: Virginia Wright - Bloorview Kids Rehab, Danielle Levac (PhD Candidate), Cheryl Missiuna, Carol DeMatteo, Laurie Wishart, Pat Miller - McMaster University
Sponsor: Physiotherapy Foundation of Canada

Dear youth,

We would like to invite you to be in a research study. We are studying how Nintendo Wii and WiiFit video games are used during physiotherapy for children and youth who have an acquired brain injury (ABI). Before agreeing to take part in this study, it is important that you understand the study and how you will be involved. **Choosing to participate or not in this study will not affect your care and treatment.**

WHAT IS THE STUDY ABOUT?

The Nintendo Wii and WiiFit are popular video games that are now being used to help children who have had an ABI to relearn balance and movement skills. Physiotherapists at Bloorview Kids Rehab are using these video games as part of their treatments. In order to understand more about how the Wii/WiiFit is used, we will watch its use during physiotherapy sessions, and we will talk to physiotherapists about how it is used.

HOW WILL I BE INVOLVED IN THE STUDY?

We plan to enroll 12 children and youth from Bloorview Kids Rehab in this study. Your physiotherapist has already decided that the Wii/WiiFit is a tool that she will likely use in treatment.

If you agree to take part in this study, we will ask you to fill out a short questionnaire including your age, grade at school, and information about your past medical history. Your physiotherapist will also be asked to fill out a short questionnaire with information relevant to your physiotherapy treatment, including the cause of your ABI and your scores on standardized assessments, such as the Community Balance and Mobility Scale.

A research assistant will videotape two physiotherapy treatment sessions during your stay at Bloorview Kids Rehab. The treatment sessions will occur about two weeks apart. This will give us a good idea of how the Wii/WiiFit is being used.

The research assistant will edit your videotape so that it shows all of the activities in which the Wii/WiiFit was used, as well as some of the other activities that are done in the rest of the treatment session. Your videotape will be kept in a locked cabinet. The research assistant will make the videotape into an MPEG file so it can be watched on a computer. The MPEG video will be put onto a password protected and encrypted memory stick. The memory stick with the MPEG video will be transferred by secure courier to McMaster University. A member of the research team will watch it at McMaster University in a private space so that others cannot see the screen. The memory stick will also be kept in a locked cabinet. Your name will not be heard at any time in the movie that we make. At the beginning of the video, there will be a 20 second written message indicating the use of this video is only for the Wii/WiiFit study. At the end of the study, your physiotherapist will take part in an interview about how and why she made decisions to use the Wii/WiiFit in her physiotherapy treatment sessions.

WHAT ARE THE BENEFITS TO ME?

You may not immediately benefit from this research. Being in the study will not affect your physiotherapy treatment in any way. Your physiotherapist will choose all of the therapy activities that are done with and without the Wii/WiiFit. You will receive a $5 Tim Horton's gift certificate as a token of appreciation for being in the study.

WHAT RISKS ARE INVOLVED IN THIS STUDY?

The risks of falling or muscle injury are the same as those in any physiotherapy session in which the Wii/WiiFit is used. Your physiotherapist will take all normal safety precautions to guard you from these risks. It is possible that you might be nervous about being videotaped during physiotherapy. The only people who will see these tapes are the researchers in the study.

DO I HAVE TO DO THIS?

Choosing to participate or not in this study will not affect your care and treatment. If you decide to take part, but change your mind at any time, that is fine. This will not affect the services you get from Bloorview Kids Rehab. There is no obligation to participate in any aspect of this project.

WHAT ELSE DO I NEED TO KNOW?

All the information we collect about you is confidential. Only the researchers will have access to the data. If the results of the study are published, your name will not be used and no information that discloses your identity will be released or published without your specific consent to the disclosure.

This study has been reviewed by the Bloorview Kids Rehab Research Ethics Committee and the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board. If you have any questions about your rights as a research participant, you may contact the Office of the Chair of the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board at 905-521-2100, Ext. 42013. At Bloorview Kids Rehab, you may contact the Research Ethics Board Coordinator at 416-424-6200, Ext. 3507.

If you would like more information about the study at any time, please contact the researcher, Danielle Levac at 905-525-9140, Ext. 21458 or by email at levacde@mcmaster.ca. You can also contact Virginia Wright at 416-424-3824 or by email at vwright@bloorview.ca.

WHAT IF I HAVE QUESTIONS?

Please ask either of us to explain anything you don't understand before signing the consent form. If you leave a voicemail message, we will return your call within 48 hours. Thank you for thinking about helping us with this project.

Yours truly,

Danielle Levac, PT, MSc., PhD Candidate
McMaster University
Phone: 905-525-9140 ext 21458
levacde@mcmaster.ca

Virginia Wright, PT, PhD
Bloorview Kids Rehab
Phone: 416-424-3824
vwright@bloorview.ca

Bloorview KIDS REHAB McMaster University

REB#____________
Client Name: ____________

CONSENT FORM FOR YOUTH AGE 16-18
Wii / WiiFit & Physiotherapy Study
Bloorview Kids Rehab & McMaster University

Re: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury.

Please complete this form and return it to a study investigator.

A research investigator has explained this study to me. I read the Information Letter dated April 2009 and I understand what this study is about. I understand that I may drop out of the study at any time.

I agree to participate in this study.

______________________ ______________________ __________
Youth's Name (please print) Signature Date

______________________ ______________________ __________
Person Obtaining Consent (print) Signature Date

REB #____________
Client Name: ____________

INFORMATION LETTER FOR PARENTS OF YOUTH AGED 16-18
Wii / WiiFit & Physiotherapy Study
Bloorview Kids Rehab & McMaster University

April 2009

Project: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury.

Investigators: Virginia Wright - Bloorview Kids Rehab
Danielle Levac (PhD Candidate), Cheryl Missiuna, Carol DeMatteo, Laurie Wishart, Pat Miller - McMaster University
Sponsor: Physiotherapy Foundation of Canada

Dear Parents/Guardians,

Your son or daughter has agreed to be in a research study. We are studying how Nintendo Wii and WiiFit video games are used during physiotherapy for children and youth who have an acquired brain injury (ABI). It is important that you understand the study and how they might be involved. **Participation in this study will not affect their care and treatment.**

WHAT IS THE STUDY ABOUT?

The Nintendo Wii and WiiFit are popular video games that are now being used to help children who have had an ABI to relearn balance and movement skills. Physiotherapists at Bloorview Kids Rehab are using these video games as part of their treatments. In order to understand more about how the Wii/WiiFit is used, we will watch its use during physiotherapy sessions, and we will talk to physiotherapists about how it is used.

HOW WILL MY CHILD BE INVOLVED IN THE STUDY?

We plan to enroll 12 children and youth from Bloorview Kids Rehab in this study. Your child's physiotherapist has already decided that the Wii/WiiFit is a tool that she will use in treatment.
We will be asking youth to fill out a short questionnaire including age, grade at school, and information about the nature of the ABI. Physiotherapists will also be asked to fill out a short questionnaire with information relevant to individual children's physiotherapy treatment, including the cause of ABI and scores on standardized assessments, such as the Community Balance and Mobility Scale. Next, a research assistant will videotape two physiotherapy treatment sessions during your child's stay at Bloorview Kids Rehab. The treatment sessions that we will videotape will occur about two weeks apart. This will give us a good idea of how the Wii/WiiFit is being used with your child.

The research assistant will edit the videotape so that it shows all of the activities in which the Wii/WiiFit was used, as well as some of the other activities that are done in the rest of the treatment session. The videotape will be kept in a locked cabinet. The research assistant will make the videotape into an MPEG file so it can be watched on a computer. The MPEG video will be put onto a password protected and encrypted memory stick. The memory stick with the MPEG video will be transferred by secure courier to McMaster University. A member of the research team will watch it at McMaster University in a private space so that others cannot see the screen. The memory stick will also be kept in a locked cabinet.

Your child's name will not be heard at any time in the movie that we make. At the beginning of the video, there will be a 20 second written message indicating the use of this video is only for the Wii/WiiFit study. At the end of the study, your child's physiotherapist will also take part in an interview about how and why she made decisions to use the Wii/WiiFit in her physiotherapy treatment sessions.

WHAT ARE THE BENEFITS TO MY CHILD?

Your child may not directly benefit from this research. Being in the study will not affect your child's physiotherapy treatment in any way. Your child's physiotherapist will choose all of the therapy activities that are done with and without the Wii/WiiFit. Your child will receive a $5 Tim Horton's gift certificate as a token of appreciation for being in the study.

WHAT RISKS ARE INVOLVED IN THIS STUDY?

The risks of falling or muscle injury to your child are the same as those in any physiotherapy session in which the Wii/WiiFit is used. Your child's physiotherapist will take all normal safety precautions to guard him/her from these risks. It is possible that your child might be nervous about being videotaped during physiotherapy. We will let your child know that the only people who will see these tapes are the researchers in the study.

DOES MY TEENAGER HAVE TO DO THIS?

Your son or daughter has read and signed a consent form indicating their understanding of what is involved to participate in the study. If they change their mind about taking part in the study at any time, that is fine. This will not affect the services they get from Bloorview Kids Rehab. Your child does not have to participate in any aspect of this project.

WHAT ELSE DO I NEED TO KNOW?

All the information we collect about your child is confidential. Only the researchers will have access to the data. If the results of the study are published, your child's name will not be used and no information that discloses his/her identify will be released or published.

This study has been reviewed by the Bloorview Kids Rehab Research Ethics Committee and the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board. If you have any questions about your rights as a research participant, you may contact the Office of the Chair of the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board at 905-521-2100, Ext. 42013. At Bloorview Kids Rehab, you may contact the Research Ethics Board Coordinator at 416-424-6200, Ext. 3507.

If you would like more information about the study at any time, please contact the researcher, Danielle Levac at 905-525-9140, Ext. 21458 or by email at levacde@mcmaster.ca. You can also contact Virginia Wright at 416-424-3824 or by email at vwright@bloorview.ca.

WHAT IF I HAVE QUESTIONS?

Please feel free to contact our research team if there is anything you don't understand.

Thank you for your time.

Danielle Levac, PT, MSc., PhD Candidate
McMaster University
Phone: 905-525-9140 ext 21458
levacde@mcmaster.ca

Virginia Wright, PT, PhD
Bloorview Kids Rehab
Phone: 416-424-3824
vwright@bloorview.ca

Bloorview KIDS REHAB | McMaster University

REB#_____________
Client Name: _____________

SUPPORT FORM FOR PARENTS
Wii / WiiFit & Physiotherapy Study
Bloorview Kids Rehab & McMaster University

Re: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury.

Please complete this form and return it to a research investigator.

I have read the information letter dated April 2009 and I have had the opportunity to ask research investigators any questions that I have. I understand that my child may drop out of the study at any time.

I support my child's decision to participate in this study.

______________________	______________________	__________
Parent name (please print)	Signature	Date

______________________	______________________	__________
Person Obtaining Support (print)	Signature	Date

Wii/ WiiFit & Physiotherapy Study
Bloorview Kids Rehab & McMaster University

Potential participants

Therapists have been identified as potential participants in the MLSRS development process based on their clinical experience with clients with ABI or their research experience with motor learning concepts.

Script for PI to invite physiotherapists to participate in MLSRS development

Danielle will contact these individuals over the telephone to invite their participation in the MLSRS development:

Hello, my name is Danielle Levac and I am a physiotherapist and PhD Candidate at McMaster University. I am calling to invite your participation in a research project. Let me explain the project and why I am inviting you to participate.

I am a member of a research team at McMaster University and Bloorview Kids Rehab undertaking a study to better understand the content of physiotherapy interventions for children and youth with Acquired Brain Injury (ABI). As a component of this project, we are developing a new rating scale to quantify the use of motor learning strategies by therapists during physiotherapy interventions. We plan to develop a simple and practical Rating Scale that can be used by a trained physiotherapist observer to rate the use of motor learning strategies during physiotherapy interventions. As a [clinician/researcher] with experience in [ABI/motor learning], we would like to invite you to participate in a focus group to provide your clinical expert opinion as to which motor learning strategies should be included in this Motor Learning Strategy Rating Scale and how their use should be scored.

If you agree to participate, we will invite you to take part in a 2-hour focus group to be held at McMaster University in the fall of 2009. Prior to the focus group, we will ask you to complete a short on-line questionnaire on a secure website called Survey Monkey to give us some information about your thoughts on the items and allow us to prepare for the meeting.

Do you have any questions about the project or the nature of your potential participation?

Are you interested in participating in this focus group?

If yes:

Great, thank you. Can I have your mailing address and email address? I will mail you the letter of information and consent as well as a return envelope for you to send the signed consent back to me. This summer, I will email you the Survey Monkey questionnaire and I will be in touch regarding proposed dates for the focus group meeting.

Thank you very much for your time. My phone number is X. Please call me if you have any questions at any point.

REB#____________
Expert's Name: ___________

MOTOR LEARNING STRATEGY RATING SCALE
FOCUS GROUP INFORMATION SHEET

Project: ***Development of a Motor Learning Strategy Rating Scale for pediatric physiotherapy interventions***

Investigators: Danielle Levac (PhD Candidate), Cheryl Missiuna, Carol DeMatteo, Laurie Wishart, Pat Miller – McMaster University.
Virginia Wright - Bloorview Research Institute, Bloorview Kid Rehab
Sponsor: Physiotherapy Foundation of Canada

April, 2009

Dear Therapists,

My name is Danielle Levac. I am a member of a research team at McMaster University and Bloorview Kids Rehab undertaking a study to better understand the content of physiotherapy interventions for children and youth with Acquired Brain Injury (ABI). As a component of this project, we are developing a new rating scale to quantify the use of motor learning strategies by therapists during physiotherapy interventions.

We would like to invite you to participate in a focus group to provide your clinical expert opinion as to which motor learning strategies should be included in this Motor Learning Strategy Rating Scale and how their use should be scored. The rationale for the study and further information on the focus group objectives are provided below.

Rationale
Physiotherapy interventions for children and youth with sensorimotor impairments often focus on learning or relearning essential functional balance and movement skills. Although physiotherapists may be encouraged by temporary improvements in ***motor performance*** during therapy sessions, promotion of ***motor learning*** - the permanent changes in motor skill capability that are retained and can be transferred and generalized to new learning situations – is an important goal. **Motor learning theory** describes how the learning environment (in which the therapist is a central component), the task, and the characteristics of the child interact to influence learning outcomes. Therapists can promote motor learning by using **motor learning strategies** within their interventions. Motor learning strategies are theory- and evidence-based guidelines that can be applied by therapists to structure presentation of the task and the learning environment.

Examples of motor learning strategies include, but are not limited to: modeling the skill to be learnt, providing verbal instructions, providing visual or verbal feedback about task performance or its outcomes, providing hands-on guidance, and organizing the structure, scheduling and amount of physical practice of motivating, goal-directed functional tasks.

The use of motor learning strategies by therapists may be readily observable during physiotherapy interventions. However, there are no existing instruments with which to document or quantify therapist use of motor learning strategies that are applied during interventions. The purpose of this project is to develop a simple and practical Rating Scale that can be used by a trained physiotherapist observer to rate the use of motor learning strategies during physiotherapy interventions.

How will I be involved in this study?
At this point, an initial list of motor learning strategies has been generated through background research and observations of physiotherapy interventions with children and adolescents at Bloorview Kids Rehab. Your physiotherapy clinical expertise is required to help narrow down this initial list of items and suggest additional items that have been missed. We also need your opinions as to how best to score the extent of use of these identified motor learning strategies.

If you are interested in participating, we will invite you to take part in a 2-hour focus group to be held at McMaster University. A package including focus group guidelines and the initial compiled list of items will be given to you via email one-two weeks prior to the session if you agree to participate. Prior to the focus group, we will ask you to complete a short on-line questionnaire on a secure website called Survey Monkey to give us some information about your thoughts on the items and allow us to prepare for the meeting. Specifically, we will ask you to review the list of items with respect to the feasibility and importance of each. You will be given a number and we will use this number, not your name, on the Survey Monkey questionnaire.

The objectives of the Focus Group are as follows:

- To discuss the initial list of motor learning strategies
- To brainstorm additional motor learning strategies to be included in the list
- To discuss and make recommendations on items to be removed from the list
- To discuss and make recommendations for how to score the Scale

We will watch a video of a physiotherapy intervention session at the start of the Focus Group, and use this to guide our subsequent discussion about the Motor Learning Strategy Rating Scale.

Confidentiality
You will be identified by a study number in the notes that are taken during the focus group session. The information that you provide will never be linked to your name in any of the summaries that are prepared. Participation in this focus group is entirely voluntary. Your name will be acknowledged as one of the experts consulted in development of the Motor Learning Strategy Rating Scale unless you indicate otherwise in writing. However, you will not have any ownership rights in the Scale.

What if I have questions?
Please ask for explanations on anything that you do not understand before signing the consent form. You may also contact Virginia Wright at 416-424-3824. Thank you for considering helping us with this research project.

Yours truly,

Danielle Levac, PT
PhD Candidate, McMaster University
Phone 905-525-9140 Ext 21458
levacde@mcmaster.ca

Virginia Wright, PT, PhD
Clinical Advisor
Bloorview Kids Rehab
vwright@bloorview.ca

Bloorview KIDS REHAB McMaster University

CONSENT FORM – PARTICIPATION IN FOCUS GROUP
(Physical Therapist)

Project: ***Development of a Motor Learning Strategy Rating Scale for pediatric physiotherapy interventions***

Investigators: Danielle Levac, Cheryl Missiuna, Carol DeMatteo, Laurie Wishart, Pat Miller – McMaster University.
Virginia Wright - Bloorview Research Institute, Bloorview Kids Rehab

Re: Motor Learning Strategy Rating Scale - Development

Please complete the following form and return it to the Researchers.

The Researchers explained this study to me. I have read the information letter dated April 2009 and I understand what this study is about.

I understand the nature of my involvement in the focus group and in the item generation process of this rating scale. I understand that my recommendations will be considered in the item selection process.

I agree to participate in the focus group component of this study.

______________________	______________________	__________
Physical therapist's Name (Please Print)	Signature	Date

______________________	______________________	__________
Researcher	Signature	Date

Bloorview KIDS REHAB | McMaster University

REB #:____________
Therapist's Name: ____________

CONFIDENTIALITY STATEMENT FOR PHYSIOTHERAPISTS
Wii/ WiiFit & Physiotherapy Study
Bloorview Kids Rehab & McMaster University

Re: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury.

April 2009

Dear Therapists,

Thank you for your participation thus far in the Wii/WiiFit & Physiotherapy Study. As stated in the letter of information about the study, we are interested in your thoughts about using the Wii/WiiFit in your physiotherapy interventions. Prior to the interview with Danielle Levac, we are asking you to sign this confidentiality statement requesting that you do not talk to your fellow Study PTs about the interview content until after all the interviews are completed. We will advise you over email as to when the interviews are completed; at that time, you are free to speak with other Study PTs about the interview content.

* * * * * * * * * * * * * * * * * *

Please complete this form and return it to a study investigator.

I agree not to speak about interview questions or my responses to the other Study PTs until after a study investigator has let me know that all interviews have been completed.

______________________ ______________________ ________
Therapist's Name (please print) Signature Date

______________________ ______________________ ________
Person Obtaining Statement (print) Signature Date

Bloorview KIDS REHAB McMaster University

REB #:_____________
Client Name: _____________

Wii/ WiiFit & Physiotherapy Videotaping
Bloorview Kids Rehab & McMaster University

<u>Script for RA to provide information to children, teenagers and parents about the videotaping</u>

(NB – the RA may be speaking to just the parent, to both parent and child, or to just teenager and will change her use of pronouns accordingly. She may also be speaking on the phone or in person)

Project: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury: videotaping physiotherapy treatment

Investigators: Dr. Virginia Wright, Bloorview Kids Rehab
Danielle Levac, PhD Candidate, Dr. Cheryl Missiuna, Carol DeMatteo, Dr. Laurie Wishart, Dr. Pat Miller, McMaster University

Participant information **Date:**__________
Participant name: ____
Parent/Guardian Name: ____
Contact phone number: ____

Hello, my name is [insert RA's name] and I am a Research Assistant at Bloorview Kids Rehab. Recently, [insert name of physiotherapist] at Bloorview Kids Rehab spoke to you about a project we are doing and mentioned that you had agreed to be contacted to hear more. Are you still interested in hearing about this project?

IF NO, Would there be a better time for me to [call/drop by]?
IF STILL NO, That's fine. I will not contact you again. Thank you for your time.

IF YES, Great!

Let me tell you more about the project. Please stop me at any time if you have a question. We are doing a in a project in which we are developing a physiotherapy treatment session rating form. This form will be used later on in a research study on the Nintendo Wii and WiiFit in which we are studying how Nintendo Wii and WiiFit video games are used during physiotherapy for children and youth.

Let me tell you what the project would require of you and your child. We are developing a form that will let us know what kinds of activities are being done in physiotherapy treatment, including Wii/WiiFit activities. For example, we might want to count what kinds of activities are done to help with walking or balance. We need to videotape physiotherapy treatment sessions for two children and youth at Bloorview Kids Rehab to help us in our ideas about what activities we will include on this form. A group of physiotherapists who work with children who have had a brain injury will be meeting with us later on to share their ideas about what information about physiotherapy treatment needs to be part of this rating form. The physiotherapists will watch the children's videos during this meeting. These videos will help to guide them in their thoughts about what we should include on the form.
There is no known risk from videotaping your child's physiotherapy session. There are also no benefits to participating in the project.

Please realize that your decision to participate, or not, will not have any impact on your child's treatment by Bloorview Kids Rehab. Your child's participation in the videotaping is completely voluntary.

Do you have any questions at this point? Are you still interested in participating in our videotaping project?

IF NO: That's fine. I will not contact you again. Thank you for your time.

Follow up process if parent says yes:

IF YES: I will give you an information and consent letter for you and a letter for your child. You will have some time to read the letters to decide if you would still like to participate, and to ask us any questions that you may have. I can also go over the project's consent form and assent form with you and your child if you would like. If you read the consent and decide not to participate, please just let us know. This is not a problem! If you would like to participate, we will ask both you and your child to sign indicating that you understand and agree to participate in the project.

Follow-up process if youth (16+) says yes:

IF YES: I will give you an information letter for you to read. The first step is to read over and sign this consent form. The consent form gives you information about the project. You can sign after you have had the chance to ask us any questions you might have. If you receive the consent form, read it over and decide not to participate, please just let us know. This is not a problem! I will also give an information form to your parent(s) to read. This is a form that explains the project to them. There is a support form that they can sign and bring back to us indicating that they understand and support your participation in the project.

Is there a good time in the next few days for me to call/drop by to go over the information package with you?

______________________ *(record date/time)*

Thank you for your time. I look forward to speaking with you again soon.

Bloorview KIDS REHAB McMaster University

REB # _______________
Client Name: ____________

INFORMATION LETTER FOR PARENTS
Wii / WiiFit and Physiotherapy Videotaping
Bloorview Kids Rehab & McMaster University

April 2009

Project: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury: videotaping physiotherapy treatment.

Investigators: Virginia Wright - Bloorview Kids Rehab, Danielle Levac (PhD Candidate), Cheryl Missiuna, Carol DeMatteo, Laurie Wishart, Pat Miller - McMaster University
Sponsor: Physiotherapy Foundation of Canada

Dear Parents/Guardians,

We would like to invite your child to be involved in a project in which we are developing a physiotherapy treatment session rating form. This form will be used later on in a research study on the Nintendo Wii and WiiFit in which we are studying how Nintendo Wii and WiiFit video games are used during physiotherapy for children and youth who have an acquired brain injury (ABI). Before agreeing to take part in this videotaping of your child's physiotherapy session, it is important that you understand how you and your child will be involved. **Choosing to participate or not in this videotaping will not affect your child's care and treatment.**

WHY ARE WE DEVELOPING THIS RATING FORM?

The Nintendo Wii and WiiFit are popular video games that are now being used to help children who have had an ABI to relearn balance and movement skills. Physiotherapists at Bloorview Kids Rehab are using these video games as part of their treatments. We would like to understand more about how they use them.

HOW WILL MY CHILD AND I BE INVOLVED IN THIS PROJECT?

Your child's physiotherapist has already decided to use the Wii/WiiFit with your child. We are developing a form that will let us know what kinds of activities are being done in physiotherapy treatment. For example, we might want to count what kinds of activities are done to help with walking or balance. We need to videotape physiotherapy treatment sessions for two children and youth at Bloorview Kids Rehab to help us in our ideas about what activities we will include on this form. A group of physiotherapists who work with children who have had a brain injury will be meeting with us later on to share their ideas about what information about physiotherapy treatment needs to be part of this rating form. The physiotherapists will watch the children's videos during this meeting.

If you and your child agree to take part in this project, a research assistant will videotape one physiotherapy treatment session during your child's stay at Bloorview Kids Rehab. Your child's videotape will be kept in a locked cabinet. The research assistant will make the videotape into an MPEG file so it can be watched on a computer. The MPEG video will be put onto a password protected and encrypted memory stick which will be transferred by secure courier to McMaster University. The memory stick will also be kept in a locked cabinet. The video will be watched by the physiotherapists in a private room at McMaster University.

Your child's name will not be heard at any time in the movie that we make. At the beginning of the video, there will be a 20 second written message indicating the use of this video is only for development of the rating form for the Wii/WiiFit study. Only the physiotherapists involved in developing the form, and those who will be learning to use the rating form later on in the Wii/WiiFit study, will see the video.

WHAT ARE THE BENEFITS TO ME OR MY CHILD?

Having your child's physiotherapy treatment videotaped will not affect his/her treatment in any way. Your child's physiotherapist will choose all of the therapy activities that are done with and without the Wii/WiiFit.

WHAT RISKS ARE INVOLVED IN THIS PROJECT?

The risks of falling or muscle injury to your child are the same as those in any physiotherapy session in which the Wii is used. Your child's physiotherapist will take all normal safety precautions to guard your child from these risks. It is possible that your child might be nervous about being videotaped during physiotherapy. We will let your child know that the only people who will see these tapes are the researchers in the study.

DO I HAVE TO DO THIS?

Choosing to participate or not in this study will not affect your child's care and treatment. If you and your child decide to take part, but if either of you changes your mind at any time, that is fine. This will not affect the services you or your child gets from Bloorview Kids Rehab. There is no obligation to participate in any aspect of this project.

WHAT ELSE DO I NEED TO KNOW?

All the information we collect about you and your child is confidential. Only the researchers will have access to the data. Your child's name will not be used and no information that discloses his/her identity will be released or published without your specific consent to the disclosure.

The study in which the form will be used has been reviewed by the Bloorview Kids Rehab Research Ethics Committee and the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board. If you have any questions about your rights as a research participant, you may contact the Office of the Chair of the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board at 905-521-2100, Ext. 42013. At Bloorview Kids Rehab, you may contact the Research Ethics Board Coordinator at 416-424-6200, Ext. 3507.

If you would like more information about the study at any time, please contact the researcher, Danielle Levac at 905-525-9140, Ext. 21458 or by email at levacde@mcmaster.ca. You can also contact Virginia Wright at 416-424-3824 or by email at vwright@bloorview.ca.

WHAT IF I HAVE QUESTIONS?

Please ask us to explain anything you don't understand before signing the consent form. If you leave us a voicemail message, we will return your call within 48 hours. Thank you for thinking about helping us with this project.

Yours truly,

Danielle Levac, PT, MSc., PhD Candidate
McMaster University
Phone: 905-525-9140 ext 21458
levacde@mcmaster.ca

Virginia Wright, PT, PhD
Bloorview Kids Rehab
Phone: 416-424-3824
vwright@bloorview.ca

Bloorview KIDS REHAB McMaster University

REB # ______________
Client Name: ____________

CONSENT FORM FOR PARENTS
Wii / WiiFit and Physiotherapy Videotaping
Bloorview Kids Rehab & McMaster University

Re: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury: videotaping physiotherapy treatment.

Please complete this form and return it to a study investigator.

A research investigator has explained this project to me. I read the Information Letter dated April 2009 and I understand how the videotapes will be used.

I agree to allow my child to participate in this videotaping.

Parent's Name (please print)	Signature	Date
Person Obtaining Consent (print)	Signature	Date

Bloorview KIDS REHAB   McMaster University

REB # _______________
Therapist Name: __________

INFORMATION LETTER FOR PHYSIOTHERAPISTS
Wii / WiiFit and Physiotherapy Videotaping
Bloorview Kids Rehab & McMaster University

April 2009

Project: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury: videotaping physiotherapy treatment.

Investigators: Virginia Wright - Bloorview Kids Rehab, Danielle Levac (PhD Candidate), Cheryl Missiuna, Carol DeMatteo, Laurie Wishart, Pat Miller - McMaster University
Sponsor: Physiotherapy Foundation of Canada

Dear Therapists,
You are being invited to participate in a project in which we are developing a physiotherapy treatment session rating form because you are a physiotherapist in the Neurorehabilitation program at Bloorview Kids Rehab (BKR). This form will be used later on in a research study on the Nintendo Wii and WiiFit in which we are studying how Nintendo Wii and WiiFit video games are used during physiotherapy for children and youth who have an acquired brain injury (ABI). **Choosing to participate or not in the project will in no way affect your employment at BKR.**

WHY ARE WE DEVELOPING THIS RATING FORM?
The Nintendo Wii and WiiFit are interactive video games that are being used in rehabilitation settings, including BKR. We are interested in how and why physiotherapists working with children and youth with ABI use the Nintendo Wii/WiiFit. We are developing a form that will let us know what kinds of activities are being done in physiotherapy treatment. For example, we might want to count what kinds of activities are done to help with walking or balance. We need to videotape physiotherapy treatment sessions for two children and youth at Bloorview Kids Rehab to help us in our ideas about what activities we will include on this form. A group of physiotherapists who work with children who have had a brain injury will be meeting with us later on to share their ideas about what information about physiotherapy treatment needs to be part of this rating form. The physiotherapists will watch the children's videos during this meeting.

WHAT WILL BE MY RESPONSIBILITIES IF I TAKE PART IN THIS PROJECT?
If you are willing to take part in this videotaping, we will ask you to help the research assistant (RA) involved with the project by making the initial contact with a patient with whom you plan to use the Wii/WiiFit during your interventions. You will then ask the parents of your eligible patients and/or the patient him/herself (depending on age) the following question: "We have a project in the Neurorehabilitation program that looks at videotaping a physiotherapy session to help us develop a rating form to understand the use of Nintendo Wii/Wii fit videogames within physiotherapy interventions for children and youth with brain injuries. Would it be okay if I asked the research assistant with the project to talk to you about it, in person or over the phone? May I pass your phone number on to the research assistant?" If they agree, we ask you to let the RA know and provide her with the phone number as soon as possible. The RA will then speak to the client and his/her family to give them more information and ask them if they would like to be part of the videotaping.
If the patient and his/her family agree to participate, we will videotape one of your intervention sessions with the child. The videotaping will not influence your treatment in any way. You are free to make decisions about the types and length of activities that you will do in your session. The only requirement is

that you use the Nintendo Wii/WiiFit at some point within the intervention session. The RA who will videotape the interventions is not a physiotherapist.

DO I HAVE TO DO THIS?
If you agree to participate in the videotaping, your participation is voluntary and you may decide to withdraw from the study at any time. There is no obligation to participate in any aspect of this project.

WHAT ARE THE RISKS AND BENEFITS TO ME?
As far as we know, there are no risks. Your professional practice leader will not see the videotape and they will not be used for performance appraisals in any way. There are no direct benefits to taking part in the videotaping. The videotaping will help us develop a form to be used in the subsequent research study. This study will increase our understanding of the kinds of physiotherapy interventions that are being provided to children and youth with ABI.

WHAT INFORMATION WILL BE KEPT PRIVATE?
Videotapes of your interventions will not be seen by anyone outside the research team and the physiotherapists who are developing the form. The research assistant will make the videotape into an MPEG video. At the beginning of the video, there will be a 20 second written message indicating the use of this video is only for the Wii/WiiFit study. The original videotape of your physiotherapy session will be kept in a locked file drawer in Virginia Wright's office in the Bloorview Research Institute. The research assistant will make this videotape into an MPEG file so it can be watched on a computer. The MPEG file will be put onto a password protected and encrypted memory stick which will be transferred by secure courier to McMaster University.

WILL I BE PAID TO PARTICIPATE IN THE PROJECT?
The videotaped session will be part of your usual paid working hours.

WHAT ELSE DO I NEED TO KNOW?
The study in which this form will be used has been reviewed by the Bloorview Kids Rehab Research Ethics Committee and the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board. If you have any questions about your rights as a research participant you may contact the Office of the Chair of the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board at 905-521-2100, Ext. 42013. At Bloorview Kids Rehab, you may contact the Research Ethics Board Coordinator at 416-424-6200, Ext. 3507. If you would like to receive more information about the study at any time, please contact the researchers at the numbers below.

WHAT IF I HAVE QUESTIONS?
Please ask me to explain anything you don't understand before signing the consent form. If you leave us a message, we will return your call within 48 hours. Thank you for thinking about helping us with this project.
Yours truly,

Danielle Levac, PT, MSc., PhD Candidate
McMaster University
Phone: 905-525-9140 ext 21458
levacde@mcmaster.ca

Virginia Wright, PT, PhD
Bloorview Kids Rehab
Phone: 416-424-3824
vwright@bloorview.ca

Bloorview KIDS REHAB

McMaster University

REB #:_____________
Therapist Name: __________

CONSENT FORM FOR PHYSIOTHERAPISTS
Wii / WiiFit and Physiotherapy Videotaping
Bloorview Kids Rehab & McMaster University

Re: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury: videotaping physiotherapy treatment

Please complete this form and return it to a study investigator.

I have read the information letter dated April 2009 and I have had the opportunity to ask research investigators any questions that I have. I understand why this videotaping is being done and how the videotapes will be used.

I agree to participate in this videotaping.

______________________	______________________	________
Therapist's Name (please print)	Signature	Date
______________________	______________________	________
Person Obtaining Consent (print)	Signature	Date

Bloorview KIDS REHAB McMaster University

REB #:_____________
Client Name: ____________

INFORMATION SHEET FOR CHILDREN AGE 7-15 YEARS
Wii / WiiFit and Physiotherapy Videotaping
Bloorview Kids Rehab & McMaster University

April 2009

Using video games during physiotherapy treatment

You are being invited to take part in videotaping of your physiotherapy treatment at Bloorview Kids Rehab. Here is some information about the videotaping.

WHY ARE WE DOING THIS VIDEOTAPING?
We are developing a rating form to help us understand the kinds of activities that are being done in physiotherapy treatment. The form will be used in a research study to understand how physiotherapists use Nintendo Wii and WiiFit games when they work with kids and teens at Bloorview.

WHY AM I BEING ASKED TO BE VIDEOTAPED FOR THIS PROJECT?
We are inviting kids and teens with a brain injury who are receiving physiotherapy to be videotaped for this project.

IF I AM VIDEOTAPED, WHAT WILL HAPPEN TO ME?
If you and your parents decide that you want to be videotaped, we will videotape the things that you and your physiotherapist do during one physiotherapy treatment. The person who will videotape you is a research assistant. She will not tell you or your physiotherapist what to do, and she will not get in your way during your physiotherapy.

Later, a small group of ten physiotherapists will watch the videotape to help them develop a rating form that will be used in the research study.

WHAT WILL I GET OUT OF BEING VIDEOTAPED?
The study in which we will use the form will help us to understand more about how physiotherapists can use the Nintendo Wii/WiiFit in physiotherapy to help kids learn movement and balance skills.

WILL I BE HURT IF I AM BEING VIDEOTAPED?
Since you are already using the Wii/WiiFit as part of your therapy, we don't think that there are extra risks to being videotaped. You may be nervous to have someone videotape what you do during physiotherapy. If you would like, you can watch the videotape to see what it looks like, but you don't have to. The only people who will see the videotapes are the researchers and physiotherapists involved in this study.

WILL ANYONE KNOW THAT I WAS VIDEOTAPED?
Only the people who are involved with the study will see your videotape and they will not know your name. We will keep the videotape locked up.

DO I HAVE TO DO THIS?

If you do not want to be videotaped, that's O.K. You can tell your parents or me that you don't want to be videtoaped. This will not affect how your therapist will treat you. If you say yes now, you can change your mind later. That is O.K. too.

WHAT IF I HAVE QUESTIONS?
You can ask questions if you do not understand any part of this project. If you have questions later, you can ask your parents to call Danielle, the study investigator, again at 905-525-9140, ext 21458.

WHAT IF I AM NOT SURE?
Your parents know about this videotaping. You can ask them questions if you don't understand what this is about. You can also ask me more about the study before you decide whether or not you want to be involved.

Danielle Levac, PT, MSc., PhD Candidate
McMaster University
Phone: 905-525-9140 ext 21458 email: levacde@mcmaster.ca

Virginia Wright, PT, PhD
Bloorview Kids Rehab
Phone: 416-424-3824 vwright@bloorview.ca

Bloorview KIDS REHAB McMaster University

REB #____________
Client Name: ____________

ASSENT FORM FOR CHILDREN AGED 7-15 YEARS
Wii / WiiFit and Physiotherapy Videotaping
Bloorview Kids Rehab & McMaster University

Using video games in physiotherapy treatment

I want to be videotaped as a part of this project.

____________________________ ____________
Name of participant Age

____
Signature

I read this form to ____ and they agreed to participate.

____
Name of Person Who Obtained Assent

____
Signature

____
Date

Bloorview KIDS REHAB   McMaster University

REB #____________
Client Name: ____________

INFORMATION LETTER FOR YOUTH AGE 16-18
Wii / WiiFit and Physiotherapy Videotaping
Bloorview Kids Rehab & McMaster University

April 2009

Project: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury: videotaping physiotherapy treatment.

Investigators: Virginia Wright - Bloorview Kids Rehab
Danielle Levac (PhD Candidate), Cheryl Missiuna, Carol DeMatteo, Laurie Wishart, Pat Miller - McMaster University
Sponsor: Physiotherapy Foundation of Canada

Dear Youth,

We would like to invite you to be involved in a project in which we are developing a physiotherapy treatment session rating form. This form will be used later on in a research study on the Nintendo Wii and WiiFit in which we are studying how Nintendo Wii and WiiFit video games are used during physiotherapy for children and youth who have an acquired brain injury (ABI). Before agreeing to take part in this videotaping of your physiotherapy session, it is important that you understand how you will be involved. **Choosing to participate or not in this videotaping will not affect your care and treatment.**

WHY ARE WE DEVELOPING THIS RATING FORM?
The Nintendo Wii and WiiFit are popular video games that are now being used to help children who have had an ABI to relearn balance and movement skills. Physiotherapists at Bloorview Kids Rehab are using these video games as part of their treatments. We would like to understand more about how they use them.

HOW WILL I BE INVOLVED IN THIS PROJECT?
Your child's physiotherapist has already decided to use the Wii/WiiFit in treatment. We are developing a form that will let us know what kinds of activities are being done in physiotherapy treatment. For example, we might want to count what kinds of activities are done to help with walking or balance. We need to videotape physiotherapy treatment sessions for two children and youth at Bloorview Kids Rehab to help us in our ideas about what activities we will include on this form. A group of ten physiotherapists who work with children who have had a brain injury will be meeting with us later on to share their ideas about what information about physiotherapy treatment needs to be part of this rating form. The physiotherapists will watch the videos during this meeting. These videos will help to guide them in their thoughts about what we should include on the form.

If you agree to take part in this project, a research assistant will videotape one physiotherapy treatment session during your stay at Bloorview Kids Rehab. Your videotape will be kept in a locked cabinet. The research assistant will make the videotape into an MPEG file so it can be watched on a computer. The MPEG video will be put onto a password protected and encrypted memory stick which will be transferred by secure courier to McMaster University. The video will be watched by the physiotherapists in a private room at McMaster University.

Your name will not be heard at any time in the movie that we make. At the beginning of the video, there will be a 20 second written message indicating the use of this video is only for development of the rating form for the Wii/WiiFit study. Only the physiotherapists involved in developing the form, and those who will be learning to use the rating form later on in the Wii/WiiFit study, will see the video.

WHAT ARE THE BENEFITS TO ME?
Having your physiotherapy treatment videotaped will not affect your treatment in any way. Your physiotherapist will choose all of the therapy activities that are done with and without the Wii/WiiFit.

WHAT RISKS ARE INVOLVED IN THIS PROJECT?
The risks of falling or muscle injury are the same as those in any physiotherapy session in which the Wii/WiiFit is used. Your physiotherapist will take all normal safety precautions to guard you from these risks. It is possible that you might be nervous about being videotaped during physiotherapy. The only people who will see these tapes are the researchers in the study.

DO I HAVE TO DO THIS?
Choosing to participate or not in this study will not affect your care and treatment. If you decide to take part, but you change your mind at any time, that is fine. This will not affect the services you get from Bloorview Kids Rehab. There is no obligation to participate in any aspect of this project.

WHAT ELSE DO I NEED TO KNOW?
All the information we collect about you is confidential. Only the researchers will have access to the data. Your name will not be used and no information that discloses your identity will be released or published without your specific consent to the disclosure.

The study in which the form will be used has been reviewed by the Bloorview Kids Rehab Research Ethics Committee and the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board. If you have any questions about your rights as a research participant, you may contact the Office of the Chair of the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board at 905-521-2100, Ext. 42013. At Bloorview Kids Rehab, you may contact the Research Ethics Board Coordinator at 416-424-6200, Ext. 3507.

If you would like more information about the study at any time, please contact the researcher, Danielle Levac at 905-525-9140, Ext. 21458 or by email at levacde@mcmaster.ca. You can also contact Virginia Wright at 416-424-3824 or by email at vwright@bloorview.ca.

WHAT IF I HAVE QUESTIONS?
Please ask me to explain anything you don't understand before signing the consent form. If you leave us a voicemail message, we will return your call within 48 hours. Thank you for thinking about helping us with this project.

Yours truly,

Danielle Levac, PT, MSc., PhD Candidate
McMaster University
Phone: 905-525-9140 ext 21458
levacde@mcmaster.ca

Virginia Wright, PT, PhD
Bloorview Kids Rehab
Phone: 416-424-3824
vwright@bloorview.ca

Bloorview KIDS REHAB

McMaster University

REB # _______________
Client Name: ____________

CONSENT FORM FOR YOUTH AGE 16-18
Wii / WiiFit and Physiotherapy Videotaping
Bloorview Kids Rehab & McMaster University

Re: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury: videotaping physiotherapy treatment.

Please complete this form and return it to a study investigator.

A research investigator has explained this project to me. I read the Information Letter dated April 2009 and I understand how the videotapes will be used.

I agree to participate in this videotaping.

________________________	________________________	__________
Youth's Name (please print)	Signature	Date
________________________	________________________	__________
Person Obtaining Consent (print)	Signature	Date

Bloorview KIDS REHAB McMaster University

REB #____________
Client Name: ____________

INFORMATION LETTER FOR PARENTS OF YOUTH AGED 16-18
Wii / WiiFit & Physiotherapy Videotaping
Bloorview Kids Rehab & McMaster University

April 2009

Project: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury: videotaping physiotherapy treatment

Investigators: Virginia Wright - Bloorview Kids Rehab
Danielle Levac (PhD Candidate), Cheryl Missiuna, Carol DeMatteo, Laurie Wishart, Pat Miller - McMaster University
Sponsor: Physiotherapy Foundation of Canada

Dear Parents/Guardians,

Your son or daughter has agreed to take part a project in which we are developing a physiotherapy treatment session rating form. This form will be used later on in a research study on the Nintendo Wii and WiiFit in which we are studying how Nintendo Wii and WiiFit video games are used during physiotherapy for children and youth who have an acquired brain injury (ABI). **Participation in this project will not affect their care and treatment.**

WHY ARE WE DEVELOPING THIS RATING FORM?

The Nintendo Wii and WiiFit are popular video games that are now being used to help children and youth who have had an ABI to relearn balance and movement skills. Physiotherapists at Bloorview Kids Rehab are using these video games as part of their treatments. We would like to understand more about how they use them.

HOW WILL MY TEENAGER BE INVOLVED IN THIS PROJECT?

Your child's physiotherapist has already decided to use the Wii/WiiFit in treatment. We are developing a form that will let us know what kinds of activities are being done in physiotherapy treatment. For example, we might want to count what kinds of activities are done to help with walking or balance. We need to videotape physiotherapy treatment sessions for two children and youth at Bloorview Kids Rehab to help us in our ideas about what activities we will include on this form. A group of physiotherapists who work with children and youth who have had a brain injury will be meeting with us later on to share their ideas about what information about physiotherapy treatment needs to be part of this rating form. The physiotherapists will watch the videos during this meeting. These videos will help to guide them in their thoughts about what we should include on the form.

A research assistant will videotape one physiotherapy treatment session during your child's stay at Bloorview Kids Rehab. The videotape will be kept in a locked cabinet. The research assistant will make the videotape into an MPEG file so it can be watched on a computer. The MPEG video will be put onto a password protected and encrypted memory stick and will be transferred by secure courier to McMaster University. The memory stick will also be kept in a locked cabinet. The video will be watched by the physiotherapists in a private room at McMaster University.

Your child's name will not be heard at any time in the movie that we make. At the beginning of the video, there will be a 20 second written message indicating the use of this video is only for development of the rating form for the Wii/WiiFit study. Only the physiotherapists involved in developing the form, and those who will be learning to use the rating form later on in the Wii/WiiFit study, will see the video.

WHAT ARE THE BENEFITS TO MY CHILD?

Being videotaped will not affect your child's physiotherapy treatment in any way. Your child's physiotherapist will choose all of the therapy activities that are done with and without the Wii/WiiFit.

WHAT RISKS ARE INVOLVED IN VIDEOTAPING?

The risks of falling or muscle injury to your child are the same as those in any physiotherapy session in which the Wii/WiiFit is used. Your child's physiotherapist will take all normal safety precautions to guard him/her from these risks. It is possible that your child might be nervous about being videotaped during physiotherapy. We will let him/her know that the only people who will see these tapes are the researchers in the study.

DOES MY CHILD HAVE TO DO THIS?

Your son or daughter has been asked to read and sign a consent form indicating their understanding of what is involved to participate in the videotaping. If they decide to take part, but change their mind at any time, that is fine too. This will not affect the services he/she gets from Bloorview Kids Rehab. He/she does not have to participate in any aspect of this project.

WHAT ELSE DO I NEED TO KNOW?

All the information we collect about your child is confidential. Only the researchers will have access to the data. Your child's name will not be used and no information that discloses his/her identify will be released or published.

The study for which this form is being developed has been reviewed by the Bloorview Kids Rehab Research Ethics Committee and the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board. If you have any questions about your rights as a research participant, you may contact the Office of the Chair of the Hamilton Health Sciences/Faculty of Health Sciences Research Ethics Board at 905-521-2100, Ext. 42013. At Bloorview Kids Rehab, you may contact the Research Ethics Board Coordinator at 416-424-6200, Ext. 3507.

If you would like more information about the study at any time, please contact the researchers, Danielle Levac and/or Viriginia Wright, at the numbers below.

WHAT IF I HAVE QUESTIONS?

Please feel free to contact our research team if there is anything you don't understand. You may reach us by phone at 416-424-3824 at email at levacde@mcmaster.ca or vwright@bloorview.ca.
Thank you for your time.

Sincerely,

Danielle Levac, PT, MSc., PhD Candidate
McMaster University
Phone: 905-525-9140 ext 21458
levacde@mcmaster.ca

Virginia Wright, PT, PhD
Bloorview Kids Rehab
Phone: 416-424-3824
vwright@bloorview.ca

Bloorview KIDS REHAB McMaster University

REB #____________
Client Name: ____________

SUPPORT FORM FOR PARENTS
Wii / WiiFit & Physiotherapy Videotaping
Bloorview Kids Rehab & McMaster University

Re: Understanding the use of interactive video games within physiotherapy treatment for children and youth who have an acquired brain injury: videotaping physiotherapy treatment

Please complete this form and return it to a research investigator.

I have read the information letter dated April 2009 and I have had the opportunity to ask research investigators any questions that I have.

I support my child's decision to participate in this videotaping.

Parent name (please print)	Signature	Date
Person Obtaining Support (print)	Signature	Date

Appendix H: Demographics Forms

1. Child Demographic Information Form for parents to complete
2. Child Demographic Information form for therapists to complete
3. Therapist Demographic Information form

Bloorview KIDS REHAB | McMaster University

Study ID No.____________

Child Demographic Information Form for Parents to complete
Wii / WiiFit and Physiotherapy Study
Bloorview Kids Rehab and McMaster University

This information will only be used for the purpose of describing the children and youth who participate in the study.

QUESTIONS ABOUT YOUR CHILD

1. Date of birth: ______________________ **(yyyy-mm-dd)**

2. What is your child's sex? ☐1 Male ☐2 Female

3. What grade is your child in? ______________________

4. Before the injury/event that brought your child to Bloorview Kids Rehab, has your child ever been diagnosed with any of the following? Check all that apply.

☐1	Visual Impairment	☐9	Pervasive Developmental Disorder (PDD)
☐2	Hearing Impairment	☐10	Attention Deficit Disorder (ADD or ADHD)
☐3	Learning Disability	☐11	Asperger Syndrome
☐4	Behavioural Disorder	☐12	Autism
☐5	Epilepsy or seizure disorder	☐13	Specific-Language Impairment
☐6	Motor coordination difficulties	☐14	Other (please specify): ______ ______
☐7	Developmental Coordination Disorder		
☐8	Previous Brain injury (at what age) _______		

Thank you for completing this form!

PLEASE RETURN THIS FORM TO THE STUDY INVESTIGATORS

Study ID No.______________

Demographic Information Form for physiotherapists to complete about the child
Wii / WiiFit and Physiotherapy Study
Bloorview Kids Rehab and McMaster University

When did the client's ABI occur? _________ - ______ - ______ (*yyyy-mm-dd*)

What was the mechanism of injury/cause of the ABI?

____

____

What was the child's Glasgow Coma Scale score at the time of their injury or the time of their initial hospital admission?

____

What other injuries did the child sustain at the time of their ABI?

____

____

At the time of completing this form, what is the child's current status?
Primary impairments in body structures/function:

____

____

GMFM Score: Stand ____________ Walk _________ Total _________
GMFM Date: _______________ - ______ - ______ (*yyyy-mm-dd*)

CB & M Score: _________
CB & M Date: _________ - ______ - ______ (*yyyy-mm-dd*)

Primary Activity and Participation Restrictions:

____

____

Thank you for completing this form!

PLEASE RETURN THIS FORM TO THE STUDY INVESTIGATORS

Appendix I: Session Log

Bloorview KIDS REHAB McMaster University

Study ID #: _______________

Physiotherapy Session Log - Definitions
Wii / WiiFit and Physiotherapy Study

Engagement
- How engaged was the child in the session?
- How motivated was the child to participate in the session?

Playfulness
- How much did the child appear to enjoy the session?
- To what extent did the child exhibit behaviours that demonstrate enjoyment, amusement or playfulness (laughing, smiling, etc)?

Energy
- What level of physical energy did the child exhibit during the session?
- Note: this is the opposite of: lethargy, fatigue

Attention to task
- How attentive was the child to the tasks/activities being practiced?
- How much redirection or refocusing from the therapist was needed?

****

Session aim/objective/goal continued:

Study ID# __________ Session #. __________

Physiotherapy Session Log **Wii / WiiFit and Physiotherapy Study**

Please complete this form following each videotaped intervention session.

What aim(s) were you working on during today's session? (Please list below). Approximately how much time did you spend on each aim?

Session aim/objective/goal	**Time (minutes)**
1. ______________________________	________
2. ______________________________	________
3. ______________________________	________
4. ______________________________	________
5. ______________________________	________

(Please continue writing on other side at the bottom of the page if necessary)

For the Wii/WiiFit component of your session:

Please rate the child's level of the following behaviours in today's session (see definitions on reverse):

ENGAGEMENT	**Low**	**Moderate**	**High**	**Very High**
PLAYFULNESS	**Low**	**Moderate**	**High**	**Very High**
ENERGY	**Low**	**Moderate**	**High**	**Very High**
ATTENTION TO TASK	**Low**	**Moderate**	**High**	**Very High**

For the non-Wii/WiiFit component of your session:

Please rate the child's level of the following behaviours in today's session (see definitions on reverse):

ENGAGEMENT	**Low**	**Moderate**	**High**	**Very High**
PLAYFULNESS	**Low**	**Moderate**	**High**	**Very High**
ENERGY	**Low**	**Moderate**	**High**	**Very High**
ATTENTION TO TASK	**Low**	**Moderate**	**High**	**Very High**

This was my ___________ (e.g. 1^{st}, 14^{th}) session using the Wii/WiiFit with this child during their entire rehabilitation stay.

Thank you for completing this form!

PLEASE RETURN THIS FORM TO THE STUDY INVESTIGATORS