Chapter 4
Interactive Computer Play in the Pursuit of Gait Optimization for Children With Cerebral Palsy:
Home, Video Games, and Motivation

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ABSTRACT

Exercise therapy delivered through interactive computer play (ICP) has been shown to be effective for improving gross motor skills, and ultimately gait, in children with cerebral palsy (CP). This chapter provides an overview of CP, its impact on, gait and the current physical therapy (PT) standard of care. The history of the home exercise program (HEP) component of standard PT care is described, along with the potential for using ICP to improve HEP. ICP systems are surveyed, and their defining features discussed. The current therapeutic use of ICP is described and directions for further development to enhance therapeutic utility presented. A theoretical framework to support ICP implementation, self-determination theory (SDT), is outlined, and an example of its exploration in a pilot effort is provided. An example of healthcare system barriers to rapid uptake of ICP is presented along with alternative strategies for deployment and recommendations for further research.

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INTRODUCTION

Physical (physio-) therapy (PT) improves gait in children with cerebral palsy (CP) as they mature (Franki et al., 2012). However, deciding which PT intervention will provide the greatest benefit to any individual child, at a given developmental stage, and in what dosage (frequency and intensity) is a multifactorial process and currently as much art as science. A limited ability to measure intervention inputs against outcomes, both immediate and longitudinal, figures prominently among the barriers to precision therapy.

Measurement implies instrumentation which, in PT, ranges from standardized and normed tests, for example, the Gross Motor Function Measure (GMFM, Alotaibi, Long, Kennedy, & Bavishi, 2014) Timed Up and Go (TUG, Carey, Martin, Combs-Miller, & Heathcock, 2016), and Six Minute Walk Test (6 MWT, Maher, Williams, & Olds, 2008) to electro-mechanical devices (for example, goniometers and hand-held dynamometers) to survey tools (for example, clinical questionnaires). Under the current standard system of care, measurement tools largely reside with the therapist in the clinic. The child with CP goes to the clinic to receive therapy, details of interventions are recorded, and progress over time is measured. The difficulties inherent in coordination of family and clinical schedules, and the inevitable vagaries of daily life result in unintended gaps in a child's therapy record and increase uncertainty of measurement. Home exercise programs (HEP) are a commonly prescribed adjunct to in-clinic therapy to enhance a child's progress toward therapy goals. However, families' reports of adherence are unverifiable, so the informative potential of HEP is not currently available to add power to intervention measurement and evaluation.

The research on HEP described in this chapter provides a window into the interpersonal dynamics and vulnerabilities experienced in families of children with CP. The home environment may have greater potential than the clinic to provide flexible blocks of time for a child to practice therapeutic exercise. In actual experience however, uncertainty about how exercises should be done, conflicting motivations among family members, and other factors have diffused the promise of HEP. Exercises performed during interactive computer play (ICP), using general market technologies such as the Nintendo Wii as well as custom-engineered systems, has been shown to be effective for improving gross motor outcomes. There is also preliminary evidence that use of ICP in HEP reduces parental apprehension and thus may increase the attractiveness of HEP and hence the feasibility of effectively extending therapy into the home. Use of computer technologies in HEP also provides the potential to leverage the information captured by these devices to more precisely measure therapy and use those measurements to improve therapeutic planning and outcomes.

Chapter Organization

The sections that follow provide background on CP and the current standard of care for gross motor therapy to improve gait. Research on the factors involved in generic HEP adherence are reviewed and a theoretical framework widely endorsed for understanding these factors, self-determination theory (SDT), is summarized. Subsequently, the application of ICP in HEP for children with CP is explored. ICP and conceptually-related systems are surveyed and their use in therapy for children with CP described. A section on measurement comes next. The state of knowledge relative to the effectiveness of ICP (with a strong focus on virtual reality (VR) systems) for improving physiological measures supportive of gait is presented. A discussion of dosage effect for therapy delivered via ICP follows. The potential for real-time monitoring of ICP-mediated exercise is explored and examples from research in progress presented.