

## Chapter 8

# Rehabilitation Gaming

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### ABSTRACT

*A recent innovation in rehabilitation is the use of serious gaming to train motor, cognitive, and social abilities. The main advantages of rehabilitation gaming are related to the motivation to engage in rehabilitation, the objectivity of rehabilitation measurements, and the personalization of the treatment. This chapter focuses on the use and effectiveness of serious gaming in rehabilitation and illustrates the possibilities and strengths in this new and exciting work field. Furthermore, a review of the literature and examples of rehabilitation games are presented. The state-of-the-art technologies and directions for future research are also discussed. Rehabilitation gaming has great potential for today's and future health care, and despite the research gaps, there is increasing evidence that gaming can positively contribute to the rehabilitation and recovery process.*

### INTRODUCTION

Until recently, both the media and scientists focused mainly on the negative consequences of digital gaming like aggressive behaviour (Ferguson, 2007; Anderson & Bushman, 2001). Fortunately, the tide has turned, and the focus has shifted to the positive effects of digital game play and the powerful, persuasive, and motivating elements of digital games are-aside for entertainment purposes-used

for the better: training, learning, and skill acquisition. Digital games that are specifically developed for these purposes are called serious games (Boyle, Connolly, & Hainey, 2011). Serious games have an explicit and carefully thought-out educational purpose and are not intended to be played primarily for amusement (Abt, 1970). Serious games have been recognized and are employed in various fields like the military and education, but have found increasing interest from the health domain,

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particularly in rehabilitation, partially due to the rise of low-cost embodied gaming.

The benefits of rehabilitation can be translated into a higher quality of life for both patients and their families. In addition, rehabilitation can result in lower costs for additional health care and higher productivity as patients may return to the workforce much faster. Furthermore, health care innovations that enhance rehabilitation could increase the benefits even more. One of the latest innovations in rehabilitation is the use of serious games for cognitive, psychological, motoric, and social rehabilitation. Rehabilitation gaming is a form of mediated rehabilitation, similar to telerehabilitation which is mediated by videophone (see, Popescu, Burdea, Bouzit, & Hentz, 2000) and rehabilitation mediated by Virtual Reality (VR) (see, Difede & Hoffman, 2002; Ready, Gerardi, Backscheider, Mascaro, & Rothbaum, 2010). The main advantages of mediated rehabilitation compared to traditional rehabilitation, in particular game-based rehabilitation, are related to the *motivation* to engage in rehabilitation, the *objectivity* of rehabilitation measurements, and the *personalization* of the treatment.

There is little doubt that digital games are highly *motivating* to play, because of the interactivity and feedback mechanisms that can increase the player's self-efficacy and mastery. Self-efficacy is the belief in one's ability to succeed in specific situations and it determines whether coping behaviour will be initiated, how much effort will be expended, and how long it will be sustained in the face of obstacles and aversive experiences (Bandura, 1977). In addition to enhanced self-efficacy, players can reach a state of optimal experience, which is called 'flow' (Csikszentmihalyi, 1975; Csikszentmihalyi & Csikszentmihalyi, 1988). When players are fully engaged with the task at hand, actions are performed automatically and an optimal balance between skills and challenge is reached. Digital games in rehabilitation can

motivate players to continue their training activity and advance in their skills while being 'in the zone.' In contrast, conventional rehabilitation can be a tedious exercise by performing the same movements over and over again and even highly motivated patients and therapists can become unmotivated and tired after numerous repetitions of the same movement. Rehabilitation that is mediated by means of technology can track and translate small unnoticeable advancements in the clients' recovery process into observable (in-game) progresses like scores, bonuses, and level advancements. A rehabilitation game can provide a client with positive feedback when most appropriate, which should preferably be provided on learning goals rather than performance goals (Dweck, 1986). In addition to game related advancements, rehabilitation games, controlled by e.g., a haptic feedback glove like the Rutgers II (see, Popescu et al., 2000), can monitor *objectively* over time the number of repetitions, strength levels, and extension distance. Therapists are highly trained in these measurements; however, the measurements can deviate between therapists and/or may sometimes be obstructed from view. Objective precise measurements and in-game scores can be used as input for the game dynamics and feedback mechanisms. Most game worlds can already be easily adapted by changing the scenery, complexity, avatar, controls, etc. A patient or therapist can use these variables to easily *personalize* the game and make it compatible with the clients' abilities and needs. Not only the patient or therapist can adapt the rehabilitation game, the game itself can also automatically adapt to the clients' progress. For example, decreasing in-game scores which reflect a decline in the rehabilitation phase can be used to adapt the difficulty level and/or in-game speed to lower values to continue progress and possibly increase the clients' motivation to carry on rehabilitating. The whole virtual environment, including the characters, scenery, and even the

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