Chapter 8
VR in Rehabilitation:
A New Frontier in Cognitive and Motor Recovery in Neurologically Ill Patients

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ABSTRACT

Neurological conditions include traumatic brain injury, Parkinson's disease, stroke, multiple sclerosis and spinal cord injuries frequently cause cognitive and movement impairments. Traditional rehabilitation methods can result in patient disengagement, limited accessibility, and inadequate functional recovery. Virtual reality has become a powerful instrument in neurorehabilitation due to its interactive, immersive, and flexible therapeutic environment for cognitive and motor recovery.Virtual reality-based exergames optimize functional recovery and improve motor development by fusing mental difficulties with physical exercise.

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1. INTRODUCTION

Overview of Neurological Disorders Affecting Cognition and Motor Function

The term "physical functioning" refers to the capacity to carry out a range of activities, from self-care (instrumental daily living activities) to more difficult mobility tasks that call on strength, endurance, and balance, such as walking or standing, which are crucial for establishing or preserving an independent way of life. Decreases in sensory or motor system function have been linked to age-related declines in physical functioning. For instance, gait was thought to be an automated motor action that required little higher-level cognitive input until recently (Pichierri et al., 2011). Memory, motion and coordination are all hampered by neurological disorders that affect cognitive and motor function, such as multiple sclerosis, stroke, Alzheimer's illness, Parkinson's disease, and others. By giving patients realistic, interactive environments, virtual reality (VR) is being used into emerging rehabilitation techniques to improve motor learning, cognitive training, and neuroplasticity. By mimicking real-world tasks and providing tailored feedback, VR-based therapy has demonstrated potential in enhancing motor function, balance, and cognitive engagement. VR's role in neurorehabilitation is still being investigated, with wearable technology and artificial intelligence being used to maximize patient recovery and long-term care (Dockx et al., 2019).

The Need for Innovative Rehabilitation Approaches

Virtual reality exposure can enhance the general well-being of healthy people if it is prioritized over reaching long-term personal objectives. Furthermore, virtual reality technologies could help patients with stroke or traumatic brain injury with their neurorehabilitation, help older adults who are experiencing social isolation and cognitive decline, and even be a crucial component of replacing lost functions with a suitable brain–computer interface (BCI) that controls robotic devices (Georgiev et al., 2021). The objective of motor rehabilitation is to help patients recover or improve their motor abilities through specialized exercises, physical therapy, and cutting-edge technology like robotic systems or VR. Strength, coordination, and dexterity can be greatly enhanced by robotic systems, allowing patients to carry out daily tasks on their own—a necessary skill for social integration and self-worth. Additionally, In reaction to experience and learning, the brain can reorganize itself and form new neural connections, a process known as neuroplasticity is stimulated by motor therapy. Following nervous system injuries, repeated and regulated ther-