

Use of Nootropics in patients with Mild Cognitive Impairment to promote neuroplasticity using Virtual Reality Neuro-Rehabilitation

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Abstract

Mild Cognitive Impairment increases an individual's susceptibility to negative health outcomes, such as increased risk of falling, other physical disabilities, increased frequency of hospitalizations, and death. The frequency of mild cognitive impairment among the elderly population around the world ranges from 3 to 42%.

The brain has a number of natural abilities to react as a highly dynamic system capable of modifying the properties of its neuronal networks. This brain plasticity may result in a high degree of spontaneous recovery, and rehabilitation training can modify and increase neural plasticity processes.

Nootropics have been shown to be effective as a therapy for the majority of dementia patients, and they are widely utilized as a stroke treatment. Although nootropics may not increase cognitive performance much when taken alone, this may be the case when paired with cholinesterase inhibitors.

In recent years, the medical sector has enthusiastically embraced the introduction of VR-based therapy for pain management, phobia treatment, cognitive and physical rehabilitation. VR provides cost-effective, accessible, flexible, and comprehensive therapies for patients who have trouble attending outpatient visits owing to distance, lack of transportation, or disability.

Introduction

Cognitive fragility is regarded as a precursor to neurodegenerative processes characterized by the combined existence of physical and cognitive weakness. Cognitive fragility can be diagnosed and prevented before dementia occurs. It is also characterized by decreased clamping force, gait speed, decreased muscle strength and memory impairment.

Mild Cognitive Impairment (MCI) increases an individual's susceptibility to negative health outcomes, such as increased risk of falling, other physical disabilities, increased frequency of hospitalizations, and death.

On the other hand, mild cognitive impairment is recognized as a transitional condition between normal aging and dementia, early identification of mild cognitive impairment occurring in the elderly in the form of memory dysfunction.

A recent meta-analysis found that the frequency of mild cognitive impairment among the elderly population around the world ranges from 3 to 42%.

In recent years, our understanding of motor learning, neuroplasticity, and functional recovery after a brain injury has evolved significantly. Research in the area of motor rehabilitation has been strengthened by innovative developments in neuroscience.

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These discoveries have been broadened by animal studies, revealing information on a vast array of molecular and physiological processes. Neuroimaging research on human patients has yielded system-wide information that often parallels animal findings.

In general, the best recoveries are associated with the most complete restoration of the brain's normal functioning architecture. Changes in interhemispheric lateralization, the activation of association cortices associated with wounded regions, and the creation of cortical representation maps are examples of how the reorganization of surviving components of the central nervous system aids behavioral recovery. Studies on animals indicate that motor learning and cortical stimulation may modify intracortical inhibitory networks, hence enabling long-term potentiation and cortical remodeling.

Virtual reality (VR) and augmented reality (AR) are now used in several areas, including healthcare. VR is the notion of simulating a 3D world artificially and focuses on the user's senses. Alternately, augmented reality (AR) is the outcome of superimposing appealing perceptual data, such as sounds, pictures, and text, over the actual environment. As viewed by the user, these worlds might be comparable to or distinct from the actual world, and their immersiveness can vary. In recent years, the medical sector has enthusiastically embraced the introduction of VR-based therapy for pain management, phobia treatment, cognitive and physical rehabilitation.

Methods

We conducted a literature review of the last 3 years on the effects of Virtual Reality based neuro-rehabilitation techniques on Mild Cognitive Impairment, as well as treatment protocols involving the use of nootropics for neurodegenerative pathologies.

The search terms are: "mild cognitive impairment", "neuroplasticity", "cognitive frailty", "Virtual Reality Rehabilitation", "Nootropics".

Results

Nootropics

"Hopefully, humanity will not wait millions of years until Mother Nature will eventually hand it a functionally better new brain, like an anniversary gift. On the contrary, man himself will directly, openly, and consciously partake in evolution." - Corneliu E. Giurgea (1981) Corneliu E. Giurgea, a Romanian psychologist and chemist, invented the term nootropic in 1972 from the Greek terms νους (nous), or "mind," and τροπή (trepein), meaning to bend or turn. Although the word nootropic initially referred to synthetic chemicals intended to improve mental capacities, it is today used to refer to anything that improves cognitive function, including minerals and botanicals found in dietary supplements.

Dr. Guirgea defined several requirements for a substance to be considered a nootropic.

It is required to: Improve memory, Enhance performance under stressful conditions, Protect the brain via physical or pharmacological measures, Enhance tonic cortical/subcortical control systems, Characteristics of minimal toxicity and negative effects. Nootropics have been shown to be effective as a therapy for the majority of dementia patients, and they are widely utilized as a stroke treatment. Several studies showed that choline alfoscerate, ginkgo biloba extract, acetyl-L-carnitine, and nicergoline improved cognition, although others reported no clinical

effect. Although nootropics may not improve cognitive function significantly when used alone, when combined with cholinesterase inhibitors, they may promote cholinergic neurotransmission, neurogenesis, and microperfusion in the frontal lobe, hippocampus and striatum, thereby delaying cognitive decline in dementia, particularly in patients with mild-to-moderate disease severity. Although nootropics may not increase cognitive performance much when taken alone, this may be the case when paired with cholinesterase inhibitors.

Other studies supported the safety and efficacy of omberacetam in VCI patients.

During omberacetam treatment, there was a significant improvement in patient well-being and a decrease in patient complaints. Omberacetam was shown to have a long-term positive effect.

How does VR help in the protocols of neuro-rehabilitation for Mild Cognitive Impairment?

When utilizing virtual reality for both stimulation and relaxation, those with cognitive impairment report reduced stress. Virtual reality technology that interacts with stimuli that are quasi-naturalistic and lifelike may be of great benefit to patients with cognitive impairment.

The use of VR treatments to treat phobias, stress, and anxiety in psychotherapy, behavioral therapy, and the diagnosis of dementia has increased. VR provides cost-effective, accessible, flexible, and comprehensive therapies for patients who have trouble attending outpatient visits owing to distance, lack of transportation, or disability. Given the expanding usage of VR in health-related domains, VR-based therapies have the potential to be effective patient management tools. VR incorporates real-time cgi, body wearable sensors, displays and other sensory inputs that may be used to offer long-term and individualized care for dementia patients.

Virtual environments are interactive, a picture is displayed augmented by sophisticated processors and by non-visual display modalities in order to persuade viewers that they are engaged in a synthetic area. Virtual reality is an artificial environment created using software and hardware in which users may enjoy near-reality experiences. Patients have a sense of "presence" or "being there" due to the resemblance between VR and real-world scenarios. Providing rapid performance feedback, a customized setting, and a greater degree of likeness to the actual world might increase participant engagement. Depending on the virtual environment (e.g., desktop, goggles, big screen, virtual room) and interaction approach (e.g., full-immersive, semi-immersive, non-immersive, and passive or active engagement), VR systems may be classified into many types.

The simplest type of virtual reality is a three-dimensional picture that can be examined interactively on a personal computer, often by manipulating keys or the mouse such that the image's content travels in a certain direction or zooms in.

BTS-NIRVANA is a technology based on infrared optoelectronic sensors that allows the patient to engage in a virtual environment. The device is equipped with a projector that displays a series of interactive activities, while an infrared camera constantly monitors the patient's movements. The implementation of this technology in a pilot study has led the researchers to conclude that VR training with BTS-Nirvana has the potential to improve cognitive abilities.

Virtual reality training with visual feedback allows users to view their own motions, which has assisted patients in adjusting their misaligned body center due to body image impairment. In addition, research demonstrates that training stimulates active task engagement by inspiring

interest and enjoyment and delivering quick visual feedback on performance to improve motor skills.

Research indicates a foundation for therapies based on evidence for people with MCI or dementia. Virtual experiences were chosen over non-virtual encounters by the participants because they enhanced their mood and lethargy. The simulated environments using these digital technologies are found to be reconfigured according to the individual's level of motor impairment.

Discussion/Conclusions

The use of virtual reality-based techniques has proven effective in recovering patients with neuro-motor disorders, having results in improving cognitive performance cited in recent years of research in this field.

However, more in-depth research is needed on the age group over 65 years, who are most likely to suffer from cognitive impairment. They have been shown to improve cerebral blood flow and influence neurotransmission and receptors essential for cognitive functioning and antioxidant activity. Considering a relatively good safety profile, nootropics could be recognized as an adjuvant to any standard therapy for cognitive disorders, where current therapeutic options are limited. The use of nootropics in combination with Virtual Reality based Rehabilitation may prove more effective than a single intervention.

A multidisciplinary approach to mild cognitive impairment can result in the prevention of dementia, increasing the quality of life of the elderly, and also their autonomy.

This multidisciplinary intervention that uses state of the art technology promotes the concept of digitalization of medicine, which has proven to be very useful in recent times, responding to the need of creating a more easy-to-use health environment, and also non-invasive and effective for people with mild cognitive impairment.

This approach can also be very effective in preventing mild cognitive impairment in the elderly.

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