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Rehabilitation of Attention Disorders Following Acquired Brain Injury Through a Novel Immersive Virtual Reality Protocol

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Background

Acquired brain injuries (ABIs) frequently lead to impairments in attentional processes, particularly in the domains of alertness and spatial attention [1], contributing to long-term functional limitations. Although current rehabilitation approaches—primarily based on paper-and-pencil tasks or computerized programs—can produce some improvements, their effectiveness remains inconsistent, and the transfer of gains to real-world functioning is often limited [2]. In recent years, immersive virtual reality (iVR) has emerged as a promising complementary tool. iVR enables high-intensity, engaging training and supports remote monitoring, including the potential for unsupervised home-based sessions [3]. These features may enhance access to rehabilitation services and better accommodate the diverse and long-term needs of individuals with ABI [4].

Project Goals

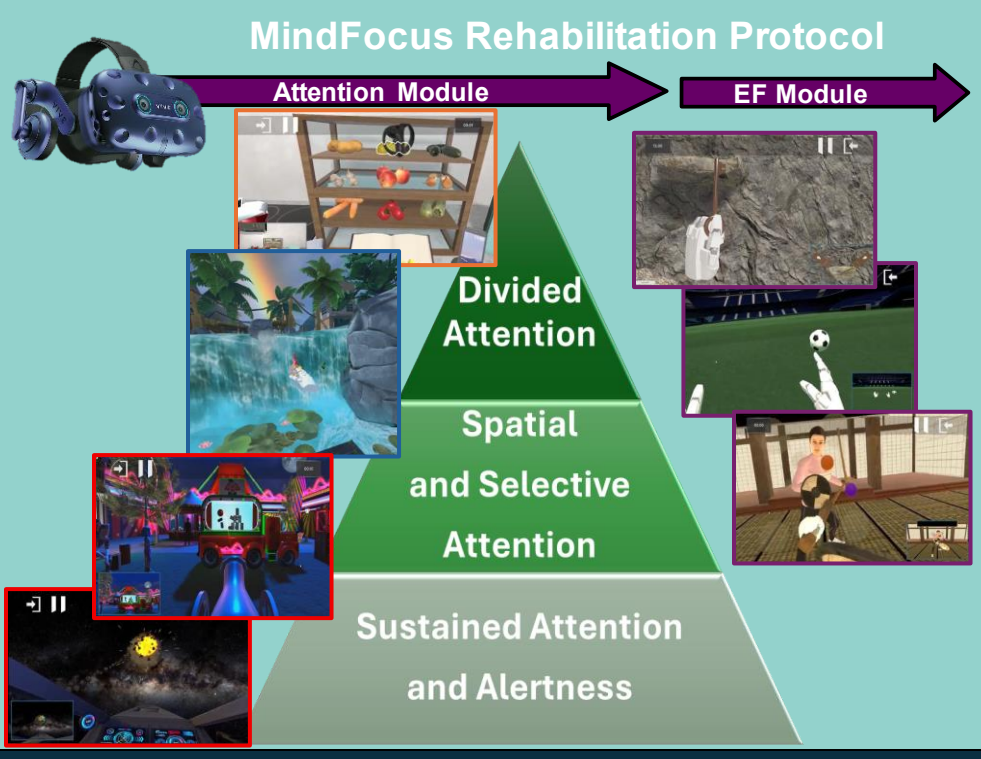
This study is part of a broader PhD project focused on the development and validation of a novel immersive virtual reality (iVR) protocol for the assessment and rehabilitation of attention and executive function deficits following acquired brain injury (ABI). A central objective of the project is to explore the potential of oculomotor metrics, recorded during iVR-based cognitive tasks, as biomarkers to support neuropsychological assessment and clinical decision-making.
The present study represents one component of this larger research initiative and specifically aims to evaluate the feasibility and effectiveness of the iVR protocol in the rehabilitation of attention deficits after ABI. In particular, the results presented here focus on improvements in alertness—a core component of attention that reflects an individual's general readiness to respond to relevant external stimuli.

Experimental Approach

Participants: 20 patients in sub-acute stage (15 Male; mean age = 56.95, SD = 12.73; mean time from lesion onset = 40.5 days) with attentional deficit after stroke were enrolled. Based on standardized clinical assessment, the included patients have objectivated alertness deficits (13 patients).

Procedure and Rehabilitation Protocol: The rehabilitation protocol includes a maximum of 20 iVR sessions (45 minutes per day, 5 days a week for one month). Given the multicomponential nature of attention, the iVR protocol (MindFocus, MindMaze SA) incorporates tasks designed to stimulate its various components based on patient cognitive profile, with self-adaptive difficulty levels. Patients were assessed before and after the intervention using subtests from the Test of Attentional Performance (TAP)

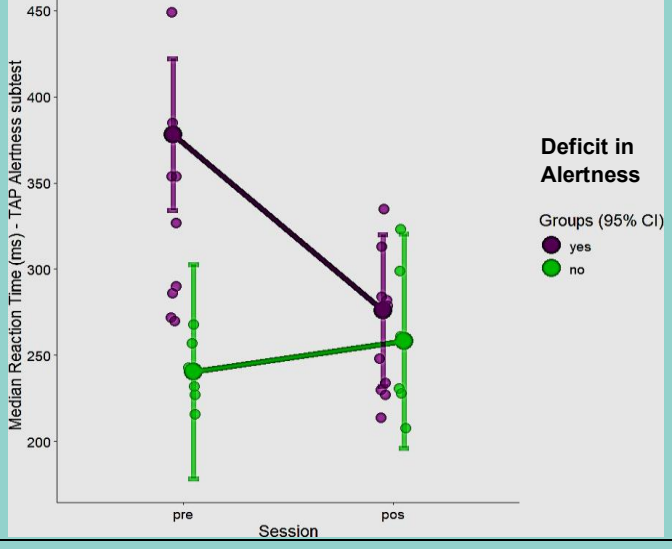
MindFocus Rehabilitation Activities. Based on single patient cognitive profile, the rehabilitation program can be customized: Attention Module → Alertness (Spaceship and Lunapark); Spatial and Selective Attention (Butterfly, Ball, Waterfall, Glyph); Divided Attention (Kitchen). Executive Function (EF) Module → Working Memory (Fencing); Cognitive Flexibility (Soccer); Planning and Decision Making (Hiking).



Expected Outcomes

A linear mixed-effects model revealed a significant session x alertness deficit interaction on median reaction time (RTs) from the "Alertness" TAP sub-test (p=.0027, η^2=.44). Participants with impaired tonic alertness showed a significant RT reduction post-intervention (p<.001), while no change was observed in those without deficits (p=.63). These results suggest that after the new immersive virtual reality rehabilitation protocol patient become faster in respond to a relevant external stimulus (pos) compared to before the training (pre).

Although here only improvement on alertness is presented, more extensive analysis showed same positive effects also for both spatial and divided attention components. These results highlight the capacity of iVR to deliver high-intensity, individualized interventions within ecologically valid and controlled environments — bridging a critical gap between structured clinical exercises and the complexity of real-world functioning. By enhancing engagement, allowing precise control of task parameters, and enabling remote or home-based applications, iVR offers a promising avenue to increase the intensity, ecological validity, and accessibility of neurorehabilitation, complementing and strengthening standard care pathways.



References: [1] Spaccavento, S., Marinelli, C. V., Nardulli, R., Macchitella, L., Bivona, U., Piccardi, L.,& Angelelli, P. (2019). Attention deficits in stroke patients: the role of lesion characteristics, time from stroke, and concomitant neuropsychological deficits. Behavioural neurology, 2019(1), 7835710. [2] Cicerone, K. D., Goldin, Y., Ganci, K., Rosenbaum, A., Wethe, J. V., Langenbahn, D. M.,& Harley, J. P. (2019). Evidence-based cognitive rehabilitation: systematic review of the literature from 2009 through 2014. Archives of physical medicine and rehabilitation, 100(8), 1515-1533. [3] Martino Cinnera, A., Bisirri, A., Chioccia, I., Leone, E., Ciancarelli, I., Iosa, M., & Verna, V. (2022). Exploring the potential of immersive virtual reality in the treatment of unilateral spatial neglect due to stroke: A comprehensive systematic review. Brain sciences, 12(11), 1589. [4] Serino, A., Konik, S., Bassolino, M., Serino, S., & Perez-Marcos, D. (2022). Immersive virtual reality for assessment and rehabilitation of deficits of body representations and cognitive functions. *Revue de neuropsychologie*, 14(1), 15-26.

SUSTAINABLE DEVELOPMENT GOALS

3 GOOD HEALTH AND WELL-BEING