Title: Virtual reality-based cognitive exercises to enhance attention and focus
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Introduction: Attention is the most crucial cognitive domain required to complete mentally challenging tasks by healthy individuals effectively. Healthy subjects may not be able to complete higher executive function tasks due to lack of focus or attention, leading to poor performance at work and home. Generally, mild attention deficits are not identified, and errors are incorrectly attributed to life stresses. Computerized cognitive training programs have been shown to improve attention deficit disorder and mild cognitive impairment. [1, 2] Virtual Reality (VR) is an emerging technology that can improve brain functions, including attention, focus, and reorientation. Studies are emerging where VR is being used to improve cognitive function and daily activities in older patients with mild cognitive impairments. [3,4] VR engages multiple learning systems, making it a more effective natural environment for cognitive training. Based on this idea, our team developed a 3D simulated software platform prototype called "ReCognition" VR with incorporated exercise in the forms of games which can improve attention, focus, and executive functions.

Methods: Virtual Reality (VR) provides sensory inputs and interactions to users by providing an artificial three-dimensional (3D) environment using computing technology or software. ReCognition VR software in Unity creates this artificial 3-D environment through the Oculus Quest 2 VR headset. The virtual environment (VE) created cognitively stimulates the user's brain to think they are in an artificial world. This VE allows flexibility and measurement of different types of stimuli while recording the various responses created by users in the controlled VE. Next, the generated VE relaxes users by playing calming beach water sound effects in the background, which helps the patient acclimate to his/her surroundings. After the user is acclimated to the environment, the nurse avatar will orient the patient to the situation, location, and time once the patient feels relaxed. Then, the patient will be instructed to use the controllers to perform mini-games with minimal physical movements to promote early mobility. These exercise "games," e.g., balloon popping, allow the patient to focus and pay attention to the game while helping reorient and cognitively stimulate the patient. The games are built with levels of increasing difficulty and complexity of user demand and output. The cognitive interventions are described in a stepwise fashion in the photographic presentation in figure -1.
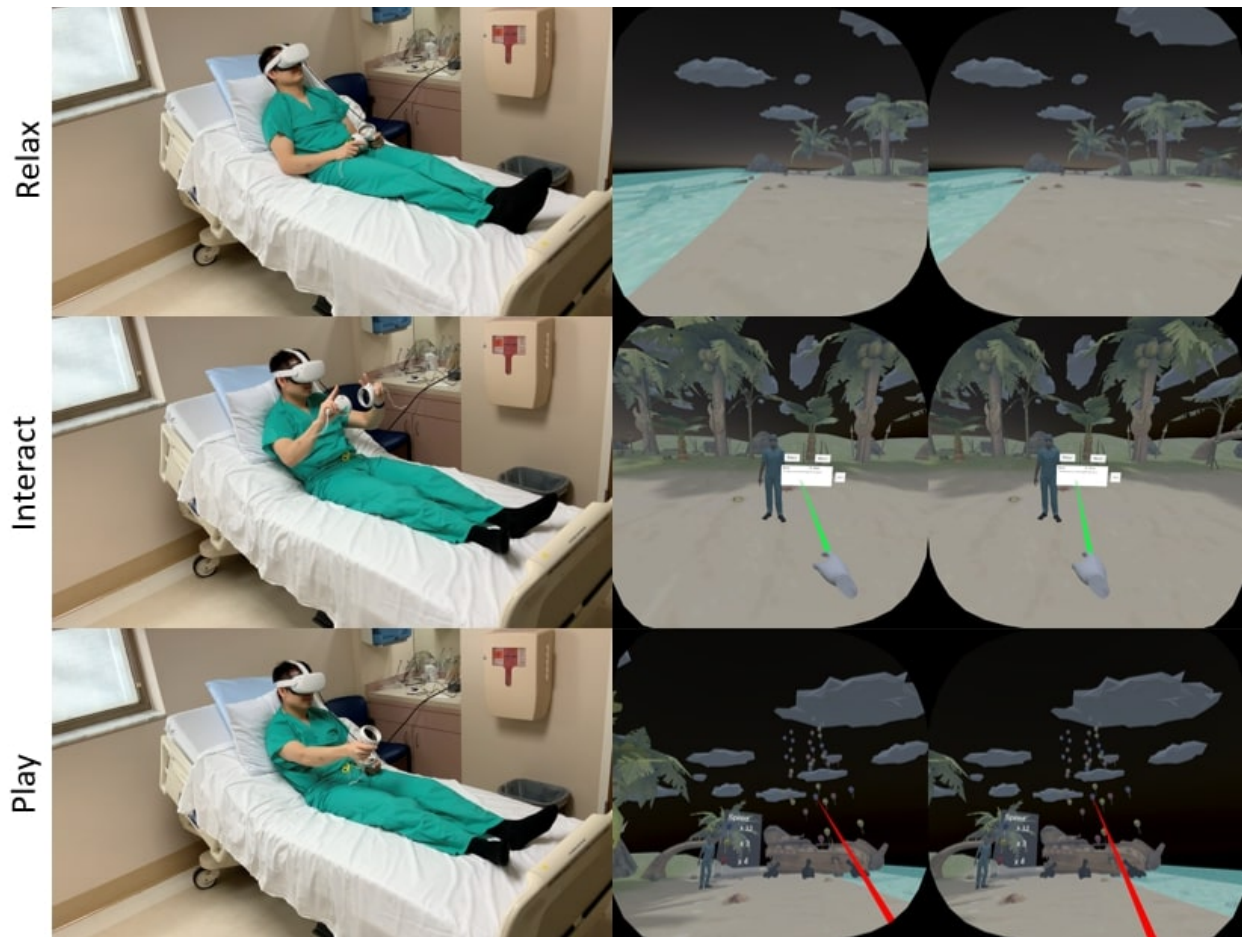
Figure 1: User views from within the ReCognitionVR software (right) with corresponding user actions (left).

Conclusion: ReCognition VR is a pilot software developed explicitly to enhance cognition's attention and reorientation domains, which are usually involved in mentally challenging tasks. The short-term goal of this project is to test the feasibility and acceptability of virtual reality-based cognitive exercises in enhancing attention and focus in healthy subjects. Contingent on promising results from healthy subject trials, the software can be expanded to be used on post-operative patients. The long-term goal of this project is to use a VR-based cognitive exercise program in clinical trials for neurological disorders involving attention and orientation domains of cognition such as delirium. It is hypothesized that early reorientation and cognitive stimulation of attention and focus can help improve prognosis and reduce the likelihood of these disorders.

References:

[1] Cho, B.-H., Ku, J., Jang, D. P., Kim, S., Lee, Y. H., Kim, I. Y., Lee, J. H., & Kim, S. I. (2002). The effect of virtual reality cognitive training for attention enhancement. *CyberPsychology & Behavior*, *5*(2), 129–137. https://doi.org/10.1089/109493102753770516

[2] Kim, B. R., Chun, M. H., Kim, L. S., & Park, J. Y. (2011). Effect of virtual reality on cognition in stroke patients. Annals of Rehabilitation Medicine, 35(4), 450. https://doi.org/10.5535/arm.2011.35.4.450

[3] Zhang, M., Zhang, J., & Zhang, D. (2019). ATVR: An attention training system using multitasking and neurofeedback on virtual reality platform. 2019 IEEE International Conference on Artificial Intelligence and Virtual Reality (AIVR). https://doi.org/10.1109/aivr46125.2019.00032

[4] Liao YY, Tseng HY, Lin YJ, Wang CJ, Hsu WC. Using virtual reality-based training to improve cognitive function, instrumental activities of daily living and neural efficiency in older adults with mild cognitive impairment. Eur J Phys Rehabil Med. 2020 Feb;56(1):47-57. doi: 10.23736/S1973-9087.19.05899-4. Epub 2019 Oct 15. PMID: 31615196.