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Virtual reality training: An invaluable tool

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ABSTRACT

In this paper, the potential use of virtual reality for use with persons with vestibular disorders is discussed. Just as optimal intervention for individuals with vestibular disorders commonly involves multiple disciplines, so are multiple disciplines conducting excellent research that demands vigilance in the practicing clinician. Vestibular exercises progress from simple movement in simple environments to complex movements in complex environments. The value of virtual reality systems for the investigation and rehabilitation of cognitive and perceptual impairments is significant. Current and potential applications of virtual reality technology address various neuro-rehabilitation issues. Vartual reality technology also allows the development of low-cost training environments consistent with a client's home environment furthermore, virtual environments are adaptable and can afford patients the opportunity to practice under a variety of simulated circumstances.

Key words: desensitization, simulated, cortical reorganization.

INTRODUCTION

Vestibular rehabilitation is an optimal intervention for individuals with vestibular disorders including benign paroxysmal positional vertigo (bppv) and the unilateral or bilateral vestibular hypofunction (reduced inner ear function on one or both sides) associated with ménière's disease, labyrinthitis, and vestibular neuritis.[1] vestibular rehabilitation has come a long way from cawthorne and cooksey exercises. The future for vestibular rehabilitation is exciting and will involve interaction with multiple disciplines.[2]the use of virtual reality (vr) to enhance vestibular rehabilitation is a relatively new concept. The novel aspect of using virtual reality in physical therapy vestibular intervention is that one can bring 'real' world situations instantaneously into the clinic.[3] through vr's capacity to allow the creation and control of dynamic 3- d, ecologically valid stimulus environments within which behavioral response can be recorded and measured, it offers clinical assessment and rehabilitation options not available with traditional methods.[4]

Virtual reality (vr) is a term that applies to computer simulated environments that can simulate places in the real world as well as in imaginary worlds. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones. Some advanced haptic systems now include tactile information, generally known as force feedback, in rehabilitation.[5] origin of the term *"virtual reality"* can be traced back to the french playwright, poet, actor and director antonin artuad. In 1968, ivan sutherland, with the help of his student bob sproull created what is widely considered to be the first virtual reality augmented head mounted display.[6]

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Rationale behind the effectiveness of virtual reality training

1. Virtual reality has the capability to create an exercise environment where the intensity of practice and positive feedback can be consistently and systematically manipulated and enhanced to create the most appropriate, individualized motor learning programme.[6]
2. The specificity and frequency of feedback provided through virtual reality regarding knowledge of performance and the knowledge of results enhances motor learning skills.[6]
3. Virtual reality also induces cortical reorganization of the neural locomotor pathways .[7]
4. Virtual reality has been shown to be a suitable tool for cognitive rehabilitation because it allows a more comprehensive, ecologically valid, and controlled environment.[8]
5. Virtual environments may offer a way to systematically assess and treat executive functions and multitasking difficulties because virtual tasks are carried out within the context of the demands found in everyday tasks. [8]

APPLICATIONS OF VIRTUAL REALITY

The primary use of virtual reality in a therapeutic role is its application to various forms of exposure therapy, ranging from phobia treatments, to newer approaches to treating post traumatic stress disorders. A very basic virtual reality simulation with simple sight and sound models has been shown to be invaluable in phobia treatment (notable examples would be various zoophobias, and acrophobias). Much as in phobia treatment, exposure to the subject of the trauma or fear seems to lead to desensitization and a significant reduction in symptoms.[5]

Another field for the use of virtual reality is physical medicine and rehabilitation and occupational therapy. Virtual reality is being tested in upper and lower limb motor rehabilitation after stroke and spinal cord injuries, and also for cerebral palsy and other disabilities. Use of haptic devices and rehabilitation robots with virtual reality games to improve motivation during exercises is being done.[5]

Virtual reality is also being used to improve walking ability, balance, and endurance for an individual with multiple sclerosis. . Fulk, george d. Reported a case study in which a patient with multiple sclerosis underwent locomotor training using a virtual reality-based balance interventions for 2 days a week for 12 weeks. The client demonstrated improvements in gait speed, gait endurance, and balance post intervention and maintained the improvements at a 2-month follow up. An interesting aspect of the vr-based balance training and locomotor training interventions used in this case report was the cognitive demands during training that were reported by the client. During both of these interventions, the client would often comment on how hard she had to think about how she was moving. For example, while performing locomotor training the client would state that she never thought about how she walked before. During therapy she had to concentrate on how she moved her legs and trunk much more than she had ever done previously. She stated that this aspect of the training was almost as challenging as the physical demands.[9]

A multitude of causes lead to gait disability including stroke. Nigel w. Tierney et al. Described an innovative approach to gait rehabilitation via a system that combines the use of traditional and advanced rehabilitation techniques with a virtual reality (vr) training environment. The vr- gait system developed consisted of vr software that generated and displayed a dynamic urban environment on a large high definition television mounted in front of a treadmill. The treadmill was paired with an overhead suspension device that can provide a patient with partial weight support. Inertial tracking was used to actively monitor a patient's posture during a training session and prompt auditory cues that encouraged a patient to maintain correct walking posture. Improved gait rehabilitation was accomplished using a vr environment composed of widely available, relatively inexpensive, and unobtrusive hardware components.[10]

Fung, et al., performed studies on gait training for stroke patients by using a treadmill mounted on a 6-degree-of-freedom motion platform with a

motion-coupled vr environment. The six degree-of-freedom system provided the unique feature of simulated turning within the environment. This system also provided auditory and visual cues as positive/negative feedback. Subjects were required to wear 3d stereo glasses to visualize the virtual environment. Test results from this project demonstrated improved gait speed with training[10]. The application of virtual reality for use with persons with vestibular disorders is significant.

Whitney susan et al designed a virtual reality device, a balance near automatic virtual environment (knave), to determine the effect of a moving visual scene in persons with and without vestibular pathology. The postural sway of 2 patients and 3 controls were compared. Persons were asked to stand while viewing a sinusoidal waveform on a force plate. Postural sway was increased in both young and older adults in the immersive virtual environment. With continuous training balance improved to a significant extent.[11]

Tracy and lathan investigated the relationship between motor tasks and participants' spatial abilities by training participants within a vr based simulator and then observing their ability to transfer training from the simulator to the real world. The study demonstrated that subjects with lower spatial abilities achieved significant positive transfer from a simulator based training task to a similar real world robotic operation task.[12]

Virtual reality in telerehabilitation is a method used first in the training of musculoskeletal patients using asynchronous patient data uploading, and an internet video link. Subsequently, therapists using virtual reality-based telerehabilitation prescribe exercise routines via the web which are then accessed and executed by patients through a web browser. Therapists then monitor the patient's progress via the web and modify the therapy asynchronously without real-time interaction or training.[13]

Virtual environments have been used as an intervention tool to improve performance in comparable real-life settings. For example, teenagers with severe learning disabilities who practiced shopping in a virtual supermarket were able to shop more quickly in a real supermarket than those who used other, non supermarket virtual environments.[8]

Despite intensive and costly rehabilitation, the participation in everyday life of people after stroke is restricted during rehabilitation, there appears to be insufficient training of instrumental activities of daily living (iadls) such as shopping, use of transportation, and cooking because they are often time-consuming and technically difficult to implement. In addition, persisting impairments in motor, sensory, and cognitive abilities may affect the person's ability to return to his or her premorbid activities. Virtual reality programmed could be used as a novel intervention tool that will allow repetitive training of real- life tasks to improve multitasking while the person is still in a rehabilitation program. In a study by rand et al poststroke patients were taken and were provided with a virtual reality environment that consisted of a vmall – a virtual supermarket that encourages planning, multitasking, and problem solving while practicing an everyday shopping task . The products had to be virtually selected and placed in a shopping cart using upper-extremity movements. Participants showed improved performance in the real world after training in a virtual environment.[8]

NEED FOR FUTURE ADVANCES IN VIRTUAL REALITY TRAINING

The implementation of visual obstacles within the vr environment along with sensors to track the leg motion is another avenue of possible future extension. While the use of a simulated environment in rehabilitation is mainly a treatment tool, it also will aid in medical decision making in patient progress and prognosis. When the system is fully developed it can be made intelligent, taking into account the patient's abilities in terms of distance, speed, weight bearing, and movement responses so that the decision of when and how much to advance the program's difficulty is automatic and based on patient performance parameters.[13]

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