

# The Effects of a Mixed-Reality Computer System on Leisure Activity For Brain Injury Individuals: A Pilot Study

Patricia C. Heyn, Ph.D.<sup>1</sup>, Beatriz C. Abreu, Ph.D.<sup>2</sup>, Kenneth J. Ottenbacher, Ph.D.<sup>2</sup>

<sup>1</sup>Division of Geriatric Medicine • The University of Colorado Health Sciences Center • Denver, CO

<sup>2</sup>Division of Rehabilitation Sciences • The University of Texas Medical Branch • Galveston, TX



## Introduction

Over the past decade, the acceptance of Virtual Reality (VR) systems as effective tools for both basic research and various training has rapidly expanded (Picture. 1). Continuing advances in VR technology has supported the development of a more usable, useful, and accessible system. While therapeutic VR has largely focused on developing virtual environments as an assessment tool, increasing evidence is favoring the use of VR systems in clinical research as an effective rehabilitation tool (Figure 1). Grealy and colleagues<sup>1</sup> observed significant cognitive and physical gains of Brain Injury (BI) patients who were treated in a VR-based physical therapeutic setting.



Picture 1

Although there is evidence of the therapeutic benefits of virtual reality applications on behavioral and psychiatric outcomes<sup>2</sup>, very little attention has been given to the application of this approach as a valuable psychophysical ergotherapeutic intervention tool (Figure 2).

Figure 2. VR-Rehabilitation Proposed Outcomes Model

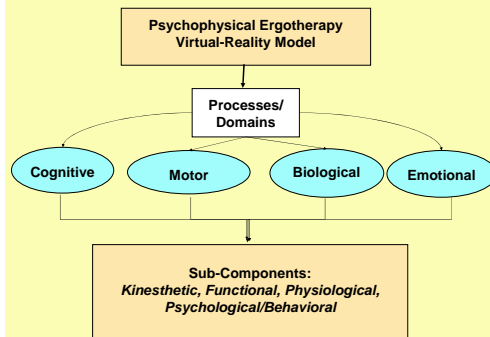
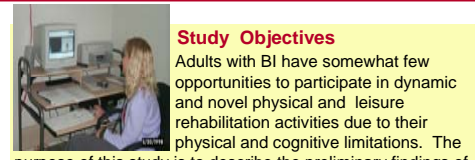
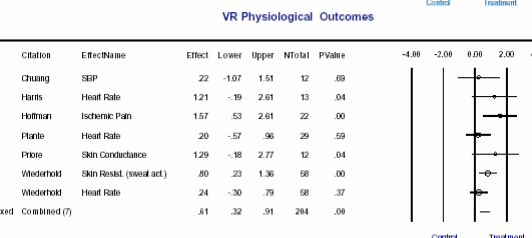
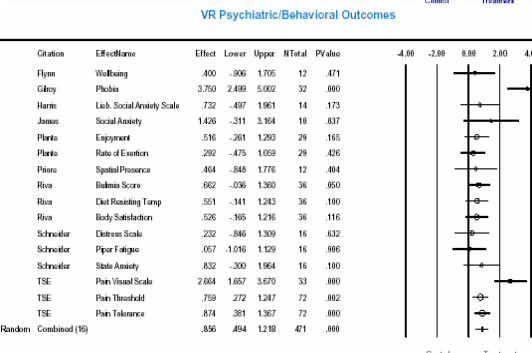
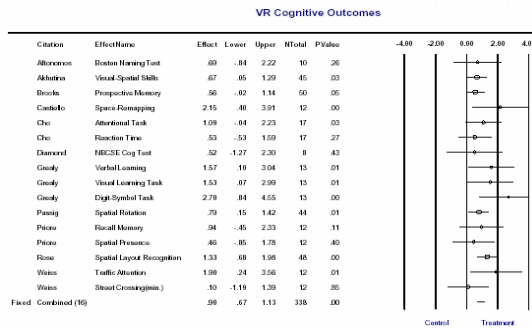
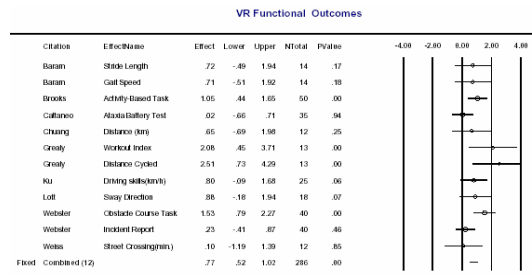


Figure 1. Summary of Effect Size Values of the VR Trials



## Study Objectives

Adults with BI have somewhat few opportunities to participate in dynamic and novel physical and leisure rehabilitation activities due to their physical and cognitive limitations. The purpose of this study is to describe the preliminary findings of a mixed-reality (semi-immersive method) rehabilitation program designed for brain injury individuals.

## METHODS

**Design**  
Quasi-experimental and observational design was used.

## Subjects

12 BI male patients from a post-acute brain injury rehabilitation center.

## Selection Criteria

Patients with a medical diagnosis of closed head injury who were able to follow instruction and give written consent were selected. Exclusion was based on the total FIM score of < 60 or FIM cognitive domain score < 20.

## Procedure

Participants were evaluated on levels of participation (total session minutes), activity enjoyment (satisfaction questionnaire), and presence (VR system immersive questionnaire) measures.

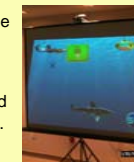
## Treatment

Mixed-Reality system was based on a video-capture from *Vivid Group's Gesture Extreme* adapted from IREX (Picture 2).



Picture 2. IREX Mixed-Reality System

Treatment consisted of a 4-wk (progressive increments) 10-40 minutes of bi-weekly sessions. The virtual environments were built to simulate specific recreational (ball & instruments play) and sports related activities (diving, soccer, beach volleyball).



## Results

- Participants were all Caucasian males, their age ranged from 20-53 yrs old, and their baseline characteristics are described on table 1.
- 60% of the sample had a BI related to motor vehicle accident, and 40% was related to gun, anoxic BI, and cerebrovascular causes.
- All participants improved participation (session duration & engagement level) from 15-20 minutes at baseline to 30-40 minutes at the end of the program.
- 70% of participants reported enjoyment and satisfaction with the program as compared to other rehabilitation modalities.
- Five participants showed a high level of presence in the mixed-reality environments.
- Four participants improved performance based on mixed-reality games baseline scoring system.

Table 1. BI Patients Baseline Characteristics

Descriptive (N=12)	Mean	SD
Age (range 20-53 yrs)	36	11.7
Glasgow (range 3-13)	6	4.0
Height (cm) (range 62-75)	70	3.4
Weight (lbs) (range 130-150)	173	34.6
BMI (range 17-31)	25.6	5.0
BP (D/S)	124/79	14/10
RHR (range 63-102)	79	12.0
Session (min) (range 8-40)	20	8.0
Session (total) (range 5-8)	6	1.7

## CONCLUSIONS

Although this pilot study has several design limitations such as small sample size and single control group, these preliminary results suggest that mixed-reality system may provide insight into brain injury rehabilitation outcomes due to increased activity enjoyment that might improve the quality of the patient engagement during therapy and stimulate participation in rehabilitation.



## References:

- [1] Grealy, M.A.; Johnson, D.A.; Rushton, S.K. Improving cognitive function after brain injury: the use of exercise and virtual reality. *Arch of Phys Med & Rehab*; 80:661-667.
- [2] Heyn, P. (2004). Virtual Reality Therapy: A systematic review of the effectiveness of interventions. *CYBERPSYCHOLOGY & BEHAVIOR*, 7 (3): 288.
- [3] Heyn, P., Schlueter, P., Push, M., & Beall, A. (2002). Gerontological applications of virtual environment as a cognitive therapy [abstract]. *The Gerontologist*, 42 (Special Issue 1), 418.
- [4] Christiansen, C., Abreu, B., Huffman, K. (1996). Creating a virtual environment for brain injury rehabilitation and research: preliminary report. *Journal of Medicine in Virtual Reality*, 6-9.
- [5] Christiansen, C., Abreu, B., Ottenbacher, K., Huffman, K., Masel, B., Culpepper, R. (1998). Task performance in virtual environments used for cognitive rehabilitation after brain injury. *Archives of Physical Medicine & Rehabilitation*, 79, 888-92.
- [6] Zhang, L., Abreu, B. C., Masel, B., Christiansen, C., & Ottenbacher, K. (2003). A virtual reality environment for evaluation of daily functional task in brain injury rehabilitation: Reliability and validity. *Arch of Physical Medicine & Rehabilitation*.

**Acknowledgment:** At the time of this study, Dr. Heyn was supported by the National Institute on Disability and Rehabilitation Research (NIDRR) Postdoctoral Fellowship Program #H13P990001 and is currently supported by the National Institute on Aging, Training Grant in Geriatric Research NIH # 1R01-HG-00279.