Abstract

Objectives: Investigate cognitive and motor benefits of integrative virtual reality (VR) games for a service member post traumatic brain injury (TBI)

Design: 6-week intervention, three sessions/week, increasing duration and game difficulty (part of randomized controlled trial).

Setting: Outpatient clinic, large military medical center.

Participants: 44-year old male, 54 months post severe TBI and a subsequent stroke, with severe difficulty in left upper extremity (UE), memory, and visual tracking.

Intervention: UECognitive bimanual training with custom adaptable VR games on the BrightBrainer Rehabilitation System®. Games induced high number of repetitions, and trained memory, focusing, and executive function. The system was adapted to participant (screen magnification with left side positioning, and for weak left grasp). (Figures 1 & 2).

Primary Outcome Measures:
- Fugl-Meyer Assessment (FMA)
- Automated Neuropsychological Assessment Metrics (ANAM) Battery

Results: Significant improvement in FMA-UE scores (points of left arm 15 to 18), 8 points on right arm (50 to 58) strength in lateral deltoid (Left—2 lbs to 4 lbs) and anterior deltoid (Left—2.5 lbs to 4 lbs), and HJT total scores (Right—283 to 252 sec) decreased from 75% to 10% over the intervention. Subject reported that the system was easy to use.

Conclusion: Case study shows benefits of bimanual intensive integrative VR games and system adaptability in a medical military setting for custom needs for a service member with complex severe deficits.

Introduction

From 2000 to 2016, approximately 357,000 service members were diagnosed with traumatic brain injury (TBI) [1]. Symptoms and functional deficits associated with TBI are heterogeneous in nature and include a combination of cognitive, emotional, behavioral, and motor deficits. Rehabilitation literature suggests the potential of utilizing post-injury neuroplasticity (similar to that of a healthy, young, developing brain) to achieve improved functional outcomes [2]. Training intensity, repetition, duration, and participant motivation/management have been identified as variables that affect the ability of the intervention to drive neuroplasticity [3].

BrightBrainer Virtual Rehabilitation (BBVR®):
- Developed by BrightCloud International
- BBVR Features:
  - Bimanual tasks to increase cognitive load
  - High number of repetitions
  - Mild upper extremity exercise that adapts to patient
- Scaleable difficulty
- BBVR Aim:
  - Facilitate neuroplasticity
  - Improve cognitive function, attentive capacity, emotional regulation, learning/memory, and motor coordination

Aims:
- Integrative and intensive virtual rehabilitation program for a service member post severe TBI.
- Motor Task Improvement
  - Simple Reaction Time
  - Learning
  - Delayed Memory

Motor Task Improvement:
- FMA-UE scores
  - 8 points on left (15 to 18)
  - 8 points on right (50 to 58)
- Strength in left lateral deltoid (2 lbs to 4 lbs)
- Strength in left anterior deltoid (2.5 lbs to 4 lbs)
- Simple reaction time (732 to 505 msec)
- Learning (1941 to 763 msec)
- Delayed memory (1065 to 796 msec)

Discussion

This case study provides preliminary support for the potential benefits of bimanual, intensive, integrative VR games for improving cognitive and UE motor functioning in patients with acquired brain injuries.

Future Research:
- Based on patient and occupational therapist reports, this system is feasible to implement in a military medical hospital setting, and engaging for participants.

References:

Acknowledgements: The authors thank the Henry M. Jackson Foundation for the Advancement of Military Medicine, Bethesda, MD. The Center for Rehabilitation Sciences Research, Bethesda, MD. Department of Rehabilitation Medicine, Uniformed Services University of Health Sciences, Bethesda, MD. University of the Sciences, Philadelphia, PA.