Introduction

From 2000 through September 2016, approximately 357,000 service members were diagnosed with traumatic brain injury (TBI) [1], and due to the increase of exposure to improvised explosive devices (IEDs) [2], experts call TBI the “signature injury of recent OIF/OEF military conflicts. Due to the complex connectivity and functional versatility of the human brain, the clinical presentation of TBI is heterogeneous in nature. Symptoms and functional deficits associated with TBI include a combination of cognitive, emotional, behavioral, and even motor deficits, which can require a multidisciplinary treatment plan and rehabilitation team.

Prior studies have confirmed the molecular plasticity of the brain, and previous research efforts have identified similarities between the molecular and cellular processes occurring in the injured brain and those occurring in the healthy, young, developing brain [3]. Rehabilitation literature suggests the potential of utilizing post-injury neuroplasticity to achieve improved functional outcomes [3].

Further, the literature also suggests that behavioral experience is the most influential modulator of neuroplasticity [3]. The factors that have been identified as variables that affect an intervention’s ability to drive neuroplasticity include training intensity, repetition, and duration, along with participant motivation/engagement [4].

Virtual Reality, when appropriately created, provides a platform to combine cognitive and motor rehabilitation into a single, integrative treatment. The specific virtual reality intervention employed in this study is called the Brightsider Virtual Reality Rehabilitation (BBVR™) system developed by Bright-Cloud International[13]. By incorporating bimanual tasks that increase cognitive load, the system aims to facilitate neuroplasticity and improve executive function, attentive capacity, emotional regulation, learning and memory, as well as motor coordination. The games are scalable in difficulty, offer high repetitions and mild exercise, and provide positive reinforcement.

Aims and Methods

Primary Aim: Evaluate feasibility of BBVR™ system in a Military Treatment Facility (MTF) rehabilitation clinic. Secondary Aim: Determine BBVR™ system efficacy in improving functional performance and alleviating neurobehavioral and affective symptoms associated with TBI.

Outcome Measures:
- Participant/Clinician Feedback Questionnaire
- Technology Acceptance Questionnaire
- Neurobehavioral Symptom Inventory (NSI)
- Quick Inventory of Depressive Symptomology (QIDS-SR)
- PTSD Checklist (PCL-C)
- Automated Neuropsychological Assessment Metric (ANAM)
- Box and Blocks Test (BBT)
- Fugl-Meyer Assessment
- Gross Shoulder Strength Test
- Jebsen Taylor Hand Function Test (JHFT)

Methods: Randomized controlled trial (expected n=20) with a wait-list control (WLC) group (fig. 2). All participants (eligible age 18-67) diagnosed TBI. The Active Treatment program consists of 3 sessions per week for 6 weeks, and the BBVR™ system tracks progress and automatically generates electronic session reports.

Preliminary Results

Currently, eight participants have completed the study. The sample contains six males (mean age = 36 years, range = 21-45) and two females (mean age = 58.5 years, range = 54-63). Relative to baseline, the sample of participants that provided valid neurocognitive test data (n=7) demonstrated a significant increase in post-intervention ANAM rank composite scores relative to the Wilcoxon Signed-Rank Test (n=7, z=-0.237, p<0.018) (fig. 3). Functional performance relative to baseline on the Jebsen Taylor Hand Function Test (JHFT) for the non-dominant hand also approached significance in the Wilcoxon Signed-Rank Test (n=7, z=-1.52, p<0.128) (fig. 5), but no other measures approached significance. On a 7-point Likert Scale, the mean participant rating of the technology was 63.5 out of 77 (fig. 4), and the mean clinician rating was 63.3.

Discussion/Future Directions

This study has demonstrated the logistical feasibility of employing virtual reality technology in an open clinic setting, and the ability to provide self-guided therapy to two patients simultaneously with a single supervising clinician. However, it should be noted that providing simultaneous treatment for two patients with severe memory deficits remains a challenge for one clinician and modified staffing plans may be required depending on patient census.

The preliminary results above suggest the potential for virtual reality applications to provide effective cognitive therapy. Although complete elimination of a “practice effect” on assessment performance is impossible, the ANAM software provides randomized stimuli across tests sessions, which creates an almost limitless number of alternative forms that help mitigate practice effects. Future analyses will examine rates of improvement during the wait-list period, for this data will enable the team to more definitively compare the effectiveness of BBVR system with that of standard cognitive therapy.

References & Acknowledgements

References:

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