Novel Clinical Application of Virtual Reality Technology for TBI

QLI
Brain and Spinal Cord Injury Specialists

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Objectives

- Participants will be able to identify three practical therapeutic applications of readily-available virtual reality tools for their own patient populations

- Participants will be able to explain current customization and adaptation developments of existing virtual reality platforms for rehabilitation use.

Terminology

- Augmented Reality
- **Virtual Reality**
  - *Non-Immersive*
  - *Semi-Immersive*
  - **Fully Immersive**

Clinical Justification

- Inherently motivating
- Dynamic
- Divided attention
- Repetitions
- Balance conflict, proprioceptive emphasis
- Full body involvement
- Easy to grade

Evidence from the last few years

- Video gaming offers similar results as conventional physical rehabilitation in most cases. (Bonnechere, et al., 2016; Yate, et al., 2016)
- The combination VR and conventional therapy is safe and effective. Likely that the combination of VR and conventional therapy is more efficacious. (Teo, et al., 2016)
- VR produced significant gains for Body Structure/Function and Activity level outcomes. Supporting evidence for the use of VR as an adjunct to conventional stroke rehab. (Aminov, et. al., 2018)
- Review of 29 studies provided evidence that VR is a useful tool for pain management. Most of the studies were short term. (Matsangidou, et. al., 2017)
- Meta analysis of 27 sources found that VRR programs are more effective overall than comparable rehab programs. VRR programs are effective but why that are effective is still unknown. (Howard, 2017).

Our clinical takeaway: VR/gaming rehab is safe, effective, motivating, and provides increased repetition as an adjunct to conventional therapy

Precautions and Contraindications

Precautions

- Vertigo/vestibular problems
- Prone to motion sickness
- Seizure history
- Easily agitated/overstimulated
- Poor dynamic trunk control
- Double vision
- Incomplete eyelid closure
- TLSO

Relative Contraindications

- Unstable C spine
- Craniectomy

Limitations of HMD VR

- Space requirements
- Limited portability of some platforms
- Weight and comfort of the headset
- Fine motor requirements
- Occluded vision
- Cords
- Cybersickness

Choose Your VR Platform

Oculus

- The first big name in VR
- Has both tethered and standalone headsets: Rift S & Quest
  - Rift S: $399+
  - Quest: $399
  - No longer making the Go
- Experiences/games through Oculus Store (Rift S)

Choose Your VR Platform

HTC Vive Cosmos

- Supports whole room VR
- Previous models similar to Oculus; now going higher end
- All games/experiences through Steam VR
- $699

Choose Your VR Platform

Sony PlayStation VR

- Bundle includes headset, PS4, and a PlayStation Camera
- Backed by Sony
- Move controllers are optional: expensive/not as capable as Oculus controllers
- Comfortable headset
- $245-$350

Choose Your VR Platform

Other

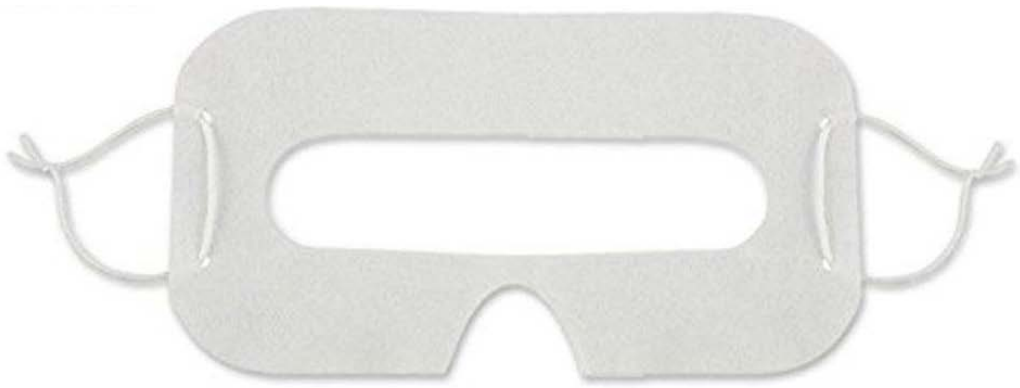
- HP Windows Mixed Reality
- Valve Index
- Cardboards/Smartphone holders

Clinic Set-Up

- Minimum space requirements – 6.5 x 5ft
- Safe place, free of obstacles
- Possibly mobile
- Safe seating

Clinic Set-Up

Safety in the Clinic



- Avoiding slips ands trips
  - Verbal cues
  - Cord management
  - Room layout
- Infection control
  - Cleaning-
    - Dry optical lens micro-fiber cloth for lenses
    - non-abrasive, alcohol free antibacterial wipes for straps, foam, earphones, and controllers.
  - VR eye masks

Controller Modifications

Tools of the Trade

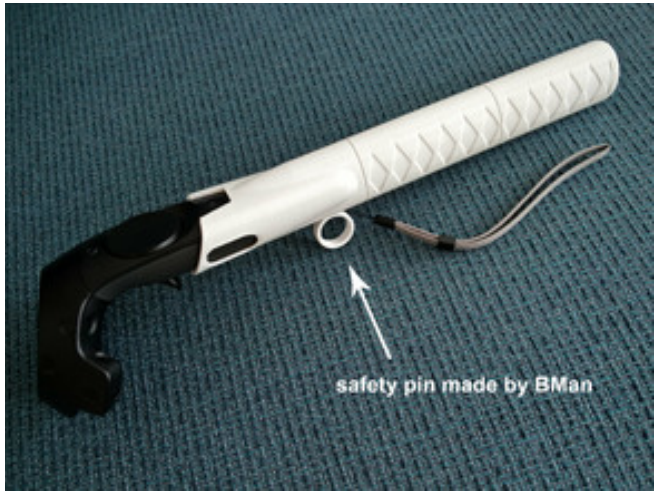
https://www.reddit.com/r/oculus/comments/8h1fzv/accidental_oculusbutton_presses_most_of_you/?st=jjf266w2&sh=88b4164d

3D Printed Adaptations

https://www.thingiverse.com/thing:2948231

https://www.thingiverse.com/thing:2915701/comments

https:/www.thingiverse.com/thing:900099/



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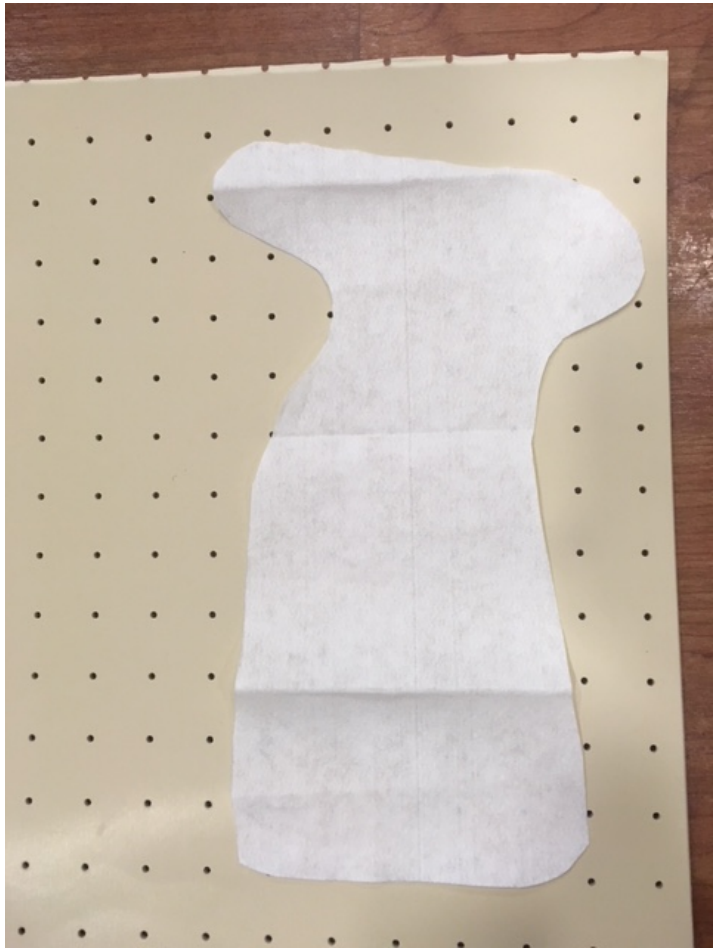
Modification Examples

Case Study

“Joe”



Game Recommendations

Vision

Vision Therapy: Visual guidance on completing five vision therapy exercises. Works with Samsung GearVR, Oculus Rift, and Steam VR.

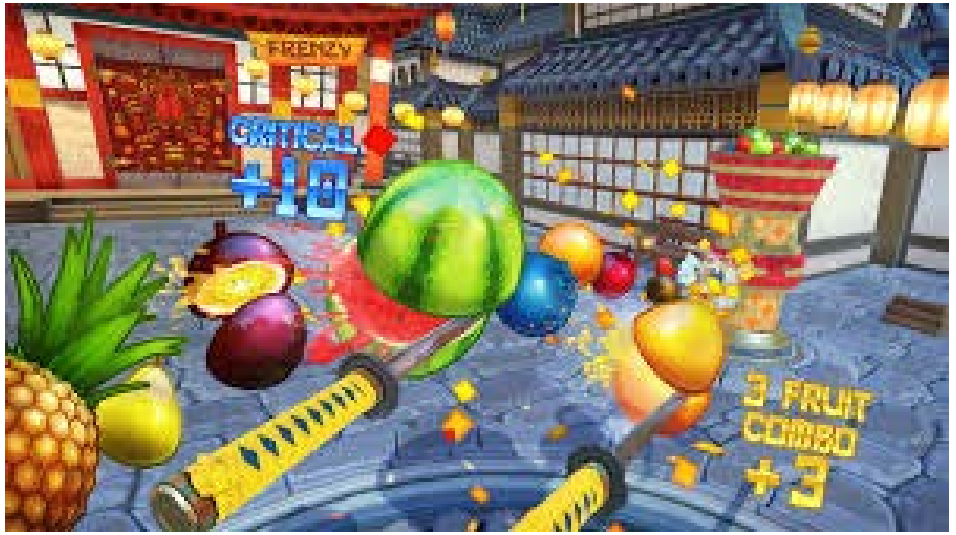
Vivid Vision: works with the Oculus Rift, HTC Vive, Samsung GearVR, and will support Google Daydream in the future. Addresses amblyopia, strabismus, suppression, acuity, stereo acuity, fusion, and convergence insufficiency.

Game Recommendations

Balance

Oculus Rift Dreamdeck: Free, highly-rated demo by Oculus that allows the user to stand or walk through

Fruit Ninja: $14.99, No fine motor requirement, weight shifting, head turns, reaction time



Ballanced: weight shifting and postural sway, vestibular challenge

Game Recommendations

Cognition

Job Simulator: Funny and engaging, simulates hands-on task performance of several virtual jobs. Forces user to divide attention, sequence.

Game Recommendations

Psych

Guided Meditation VR: Guided sessions in meditation and has the ability to measure heart rate. Available for HTC Vive, Gear VR, and Oculus Rift.

AppliedVR: Subscription-based, clinically validated program designed specifically for healthcare use. Provides a “VR Pharmacy” with a suite of experiences for pain management and anxiety.

Grading

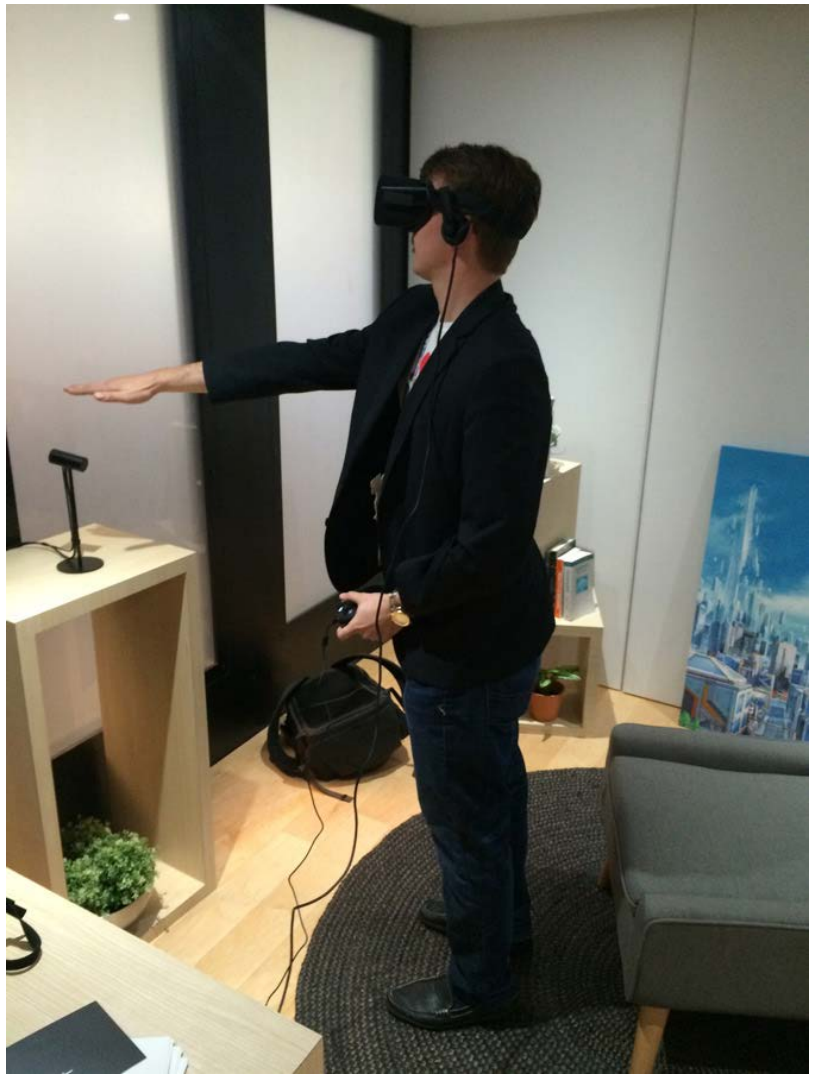
- Sitting in w/c > stationary chair > office chair > standing with assist > standing without assist
- One controller > two controllers
- Short duration > long duration
- Without distractors > with distractors
- With verbal cues > without
- With hands on assistance > without
- Without controllers > with

Examples

PT/Standing

Documentation- While engaged in a virtual task using an Oculus Rift, Erin stood for 10 minutes with CGA.

STG- Erin will stand for at least 20 minutes with close SBA while engaged in a virtual task targeting dynamic standing balance and endurance.



Examples

OT/Hand Use

Documentation- Erin sustained 5 minutes of thumb movements with min A using an oculus rift controller while engaged in a virtual task aimed at eliciting repetitive finger movements.

STG- Erin will sustain at least 10 min of unassisted thumb movements while engaged in a virtual task.

Other Measurement Examples

- Position and seated surface
- Balance- base of support, number of balance corrections
- Approximate goniometric measures of AROM at shoulder or elbow
- Number/type of grasp patterns exhibited
- Qualitative measures

Future Directions

- Multi-modal/intervention therapy- electrical stimulation, standing frames, passive range of motion, etc.
- Micro-controller and single board computers to make customizable controllers
- More rehabilitation specific game development
- Virtual assessments and measurements
- Further collaboration between clinicians, researchers, and biomechanics/computer science professionals

References

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