Connecting Virtual Reality and Occupation

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Objectives

• 1) interpret the current research on the therapeutic use of immersive virtual reality in rehabilitation.

• 2) analyze the capacity of different immersive virtual reality platforms and activities in order to facilitate a patient’s performance skills and treatment goals.

• 3) integrate immersive virtual reality technologies with evidence-based treatment strategies and techniques to enhance their practice.
The Virtual Context and The Reality - Virtuality Continuum
### The Tangible and Virtual Contexts of ADL

<table>
<thead>
<tr>
<th>Activity: Tangible Context</th>
<th>Activity: Virtual Context</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brick/mortar banking, shopping</td>
<td>Mobile banking, bitcoin, shopping</td>
</tr>
<tr>
<td>Meetings, scheduling</td>
<td>Videoconferences, digital schedules</td>
</tr>
<tr>
<td>Checkers/chess</td>
<td>Online or VR checkers/chess</td>
</tr>
<tr>
<td>Travel</td>
<td>VR travel experience</td>
</tr>
<tr>
<td>Brick/mortar education</td>
<td>Asynchronous online education</td>
</tr>
<tr>
<td>Religious services, running club</td>
<td>Online religious services, social networking services</td>
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</tbody>
</table>

* Whether a person engages through a tangible or virtual context with an activity, they still require physical interaction and an interface/tool/technology (Until we become telepathic and telekinetic...)*
Reality – Virtuality Continuum

- Real Environment
- Augmented Reality (AR)
- Augmented Virtuality (AV)
- Virtual Environment

Mixed Reality (MR)
Reality – Virtual Reality

- **Reality** - environments consisting solely of real objects
  - constrained by the laws of physics
  - real-world scene viewed in-person or displayed on a monitor or head mounted display (HMD)

- **Virtual Reality (VR)** – synthetic environments consisting solely of computer-generated virtual objects
  - may simulate real or fictional environments
  - may or may not follow laws of real-world physics
  - digital scene viewed on a monitor or HMD
Mixed Realities

- **Augmented Reality** - real environment viewed with a portion of VR added
  - can be layered or anchored/scalable to the real environment
- **Augmented Virtuality** – VR viewed with a portion of the real environment added
  - can be video or texture mapped
  - can be completely or partially immersive
Virtual Reality Concepts
VR Concepts

• Experiential vs. User Controlled

• Virtual Environments
  • Non-immersive
    • Video games, internet computer games, Wii games, Xbox Kinect games, Robotics/exoskeletons
  • Mixed
    • Augmented Reality; ie. Pokemon Go, Hololens, Cave
    • Augmented Virtuality; ie. PlayStation Eyetoy, IREX VR system
  • Immersive
    • Heads up displays with/without tracked body
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Non-Immersive VR?
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Mixed Reality AR
Mixed Reality AV
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Evaluating and Understanding the Virtual Reality Evidence
VR Evidence: Stroke

• AHA Stroke Rehabilitation Guidelines:
  • It is reasonable to provide repeated VR to improve neglect symptoms after stroke.
  • It is reasonable to consider VR as a method for delivering upper extremity movement practice.
  • The use of VR to improve visual-spatial/perceptual functioning may be considered.

• Customizing VR rehabilitation tasks according to the clinical needs and capacities of patients is important (Aminov, Rogers, Middleton, Caeyenberghs, & Wilson, 2018)
VR Evidence: Stroke

• May be beneficial in improving upper limb function and ADL function when used as an adjunct to usual care or when compared with the same dose of conventional therapy. (Laver et al., 2017)

• VR rehabilitation moderately improves outcomes compared to conventional therapy (Lohse et al., 2014)
VR Evidence: Stroke

• Meta-analyses and systematic reviews suggest adjunct treatment with IVR provides
  • engaging, motivating, task-oriented and salient experiences
  • the requisite use, repetition and intensity of training for skill acquisition and performance.
  • immediate and longer-term improvements in motor function and the performance of cognitive and motor activities following stroke. (Aminov, Rogers, Middleton, Caeyenberghs, & Wilson, 2018)
VR Evidence: Limb Loss

• Quantitative or qualitative Improvement noted with VR and AR treatment for phantom limb pain (Dunn et al., 2017)

• VR rehabilitation with a bimanual coordination task
  • encourages patient's motivation, multimodal sensorimotor re-integration of a phantom limb and improves pain (Osumi M. et al., 2016)
VR Evidence: Burn Care

• VR significantly reduces pain, anxiety and stress during dressing changes and therapy (Scapin et al., 2018)
VR Evidence: Exertion

• Measurement of cardiovascular conditioning with IVR demonstrates increased engagement with a lower perception of exertion compared to actual exertion while maintaining comparable exertion activity levels such as walking, running and dancing. (Yoo, Ackad, Heywood, & Kay, 2017)
VR Evidence: Cognition Eval

- Exploratory research demonstrates the use of IVR in the evaluation and treatment of cognitive and spatial impairment with early evidence suggesting the convergent validity of an IVR cognitive assessment with traditional neuropsychological measures. (Davison, Deeprose, & Terbeck, 2018)
Research Reality: Considerations/Limitations

• Need to standardize the definition of VR
• Used as part of a comprehensive rehabilitation program appears reasonable, taking into account the patient’s goals, abilities, and preferences
• Significant heterogeneity and small study sizes limit the power of the conclusions
• Not clear yet which characteristics of VR are most important
Research Reality: Considerations/Limitations

• Unknown whether effects are sustained
• Adverse affects may vary depending on the characteristics of the person, the VR hardware and software, and the task
• It is necessary to emphasize the importance of methodological rigor in clinical studies to improve the evidence of VR use
Research Reality: Considerations/Limitations

• Recommendations promoting the use of VR were mostly based on
  • non-immersive VR and MR environments including 2D and 3D interactive video or motion capture
  • keyboard or mouse-based interfaces
  • console game systems such as the Xbox Kinect and Wii.

• Recommendations can create confusion when therapists generalize treatment results between different types of VR, particularly to treatment with immersive VR
Assessing Virtual Reality Platforms & Activities
PlayStation4 VR

• **Pros**
  • Easy and quick setup and portability
  • Works well for trunk balance / control
  • Headset tracking / neck ROM
  • Comfortable to wear / minimal face weight
  • Standing or seated gaming

• **Cons**
  • Limited motion control, requires hand function for basic controls
  • Controller tracking is not as robust
  • Limited room scale / ability to move around room
Oculus Rift

• Pros
  • Easy setup, but a little time needed
  • Easy portability
  • Works well for trunk balance / control
  • Adaptable headset tracking / neck ROM
  • Good UE (or LE) motion tracking in standing / sitting

• Cons
  • Requires hand function for basic controls
  • Limited room scale / ability to move around room
  • Some weight on face
  • Requires powerful computer / graphics card
Windows Mixed Reality

• Pros
  • Easy / fast setup and portability
  • Inside-out tracking / No external cameras needed
  • Works well for trunk balance/control
  • Headset tracking/neck ROM
  • Good UE motion tracking in standing or sitting
  • Room scale / Capability to move throughout room
  • Lower computer and graphic card requirements

• Cons
  • Requires hand function for basic controls
  • Limited 360° tracking
Linking VR to Goals

• Match type of VR to client-specific goals/interests.
  • The goal is more important than the tool
• Use activity analysis (“Research”) to understand specific game’s accessibility and gradability
• “Research” will allow clinician to use creativity and clinical reasoning to monitor/adjust equipment and software to facilitate progress toward goals
Linking VR to Goals

• “Research” will also allow clinician to;
  • anticipate, accommodate, and manipulate client responses to the mismatch of physics between reality and virtuality
  • Incorporate treatment interventions or strategies into the activity
    • bilateral training
    • visual/sensory scanning
    • cognitive cueing
    • strength / endurance / balance
Integrating Virtual Reality in Practice: Video Case Presentations
Lower Body Dressing With C6 Asia A SCI: Trunk Control
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Lower Body Dressing With C6 Asia A SCI: Trunk Control
Lower Body Dressing With C6 Asia A SCI: Collar Off
Scanning Strategies:
Mild Left Neglect
Scanning Strategies:
Mild Left Neglect
Scanning Strategies: Mild Left Neglect
Standing Self Care/Mobility
LE Weakness/Proprioceptive Awareness L1 ASIA D SCI
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LE Weakness/Proprioceptive Awareness L1 ASIA D SCI

Function at Discharge
Summary

• Virtual reality is increasingly being used in clinics and in research to address many client factors and performance skills.

• It facilitates treatment that can foster an ecologically valid context, in a safe and controlled environment, to improve cognitive, perceptual and motor performance.

• The evidence suggests that virtual reality treatments should be used in addition to therapy occurring in a real environment vs. a stand-alone treatment.
References:


