Virtual Reality Video Games to Promote Movement Recovery in Stroke Rehabilitation: A Guide for Clinicians

After stroke, people often have difficulty moving one arm and hand, but movement can improve with considerable practice. Arm movements may need to be repeated upwards of 2500 times for a person to approach his/her peak level of motor function. Video-gaming technology can effectively deliver engaging, high-repetition movement practice. Use of video games for rehabilitation can be as effective as more conventional approaches.

There are 2 types of inexpensive, commonly available gaming systems that can be integrated into rehabilitation programs: controller based and camera tracking. In order for the systems to be used most effectively, it is necessary for therapists and/or individuals with stroke to assess both system types to determine which system best suits their needs and impairments.

The following are examples of systems and games that incorporate movements that may be useful for rehabilitation. This is not intended to be an exhaustive list, as new games and gaming systems are constantly being introduced to the market.

Authorship

“Virtual Reality Video Games to Promote Movement Recovery in Stroke Rehabilitation: A Guide for Clinicians” was developed by Kelly R. Anderson, OTR/L, Michelle L. Woodbury, PhD, OTR/L, Kala Phillips, BA, and Lynne V. Gauthier, PhD. This information/education page may be reproduced for noncommercial use for health care professionals to share with patients and their caregivers. Any other reproduction is subject to approval by the publisher.

Disclaimer

This information is not meant to replace the advice from a medical professional. You should consult your health care provider regarding specific medical concerns or treatment.

References

<table>
<thead>
<tr>
<th>Comparison Criteria</th>
<th>Controller-Based Systems (eg, Nintendo Wii, PlayStation Move)</th>
<th>Camera-Tracking/Motion Capture Systems (eg, Microsoft Kinect)</th>
</tr>
</thead>
</table>
| System description  | • Game play is enabled by a hand-held device called a “controller” that has a built-in accelerometer and gyroscope to detect the direction and magnitude of acceleration for the player’s hand movement.  
• A balance board accessory incorporates sensors to detect weight shifts while a player is sitting or standing. | • Game play is enabled with a video camera that uses an infrared depth sensor (located 4–13 feet from the player) to track the player. Players control game play by performing gestures or body movements. |
| Advantages          | • Game play is not affected by equipment or people around the player because movement is tracked with a hand-held controller.  
• A therapist can address balance and postural control by adding balance board accessories.  
• A therapist can address grasp and fine motor skills because players are required to hold the controller and push buttons. | • Specific movement patterns drive game play, thereby discouraging players from using atypical or compensatory movement patterns. For example, the player cannot compensate for decreased shoulder flexion by leaning forward with the trunk.  
• Both simple and complex movements can drive game play; custom games can target particular motor sequences.  
• A figure on the screen mirrors the player’s movements. This provides visual feedback on movement quality.  
• Fine motor skills and active grasp are not required because there are no buttons to push or controller to hold. |
| Limitations         | • Since the system tracks only the movement of the controller, intended and compensatory movement patterns are indistinguishable. For example, a player can “throw” a bowling ball by twisting the trunk instead of swinging the arm.  
• Therapists are unable to adjust game settings (speed/difficulty of play).  
• Many games require the player to hold the controller and press/release small buttons. | • Older models do not detect hand, wrist, or forearm movements.  
• Shiny or reflective surfaces, such as mirrors, windows, or wheelchairs, can interfere with infrared detection of a player’s location or movements.  
• The system can be confused by equipment or other people in the camera’s view. This may result in the figure on the screen not matching the player’s posture or movements.  
• Therapists are unable to adjust game settings (speed/difficulty of play). |
| Appropriate candidates | • Players who are able to grasp the controller and push/release its buttons  
• Speed, coordination, and accuracy of arm movement  
• Standing balance  
• Standing balance  | • Players who have some ability to move their arms away from their body  
• Movement time, peak velocity, and functional arm use  
• Range of motion and functional reaching  
• Balance and weight shifting in sitting and standing |
| Impairments targeted | • Speed, coordination, and accuracy of arm movement  
• Standing balance  | • Movement time, peak velocity, and functional arm use  
• Range of motion and functional reaching  
• Balance and weight shifting in sitting and standing |
<table>
<thead>
<tr>
<th>System Games or Packages</th>
<th>Game Description</th>
<th>Body Part Targeted</th>
<th>Speed/Difficulty of Game</th>
<th>Movement Goals Addressed</th>
<th>To Control the Game, the Player Must Be Able to:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Wii Games</strong></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Wii Sports (package)</td>
<td>Players imitate the motions required in various sports (eg, imitating the swing required for golf, tennis, and baseball).</td>
<td>One or both arms (game dependent)</td>
<td>Varies by game; some are self-paced, while others require movements in reaction to a target.</td>
<td>Upper extremity movement speed, coordination, endurance, and range of motion</td>
<td>Maintain grasp on the hand-held controller and push/release buttons during arm motion.</td>
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<td>Wii Fit (package)</td>
<td>Players engage in balance (simple yoga poses), aerobic exercise (running in place), and strength-training activities (pushups or leg lifts).</td>
<td>Full body (emphasis on trunk stability)</td>
<td>Self-paced</td>
<td>Balance, weight shift, leg lifts, strength, endurance, weight-bearing through arms</td>
<td>Grasp a hand-held controller and push/release buttons. Maintain balance to stand or sit on a balance board that is the size of a small step.</td>
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<td>Just Dance (game)</td>
<td>Players follow sequences of whole-body dance moves to receive a score.</td>
<td>Full body</td>
<td>Speed determined by song/dance selected</td>
<td>Imitation of whole-body postures with rhythmic full-body movements</td>
<td>Maintain grasp on the hand-held controller and push/release small buttons while simultaneously performing full-body movements.</td>
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<td>Zumba Fitness (game)</td>
<td>Players follow dance-like exercise routines.</td>
<td>Full body</td>
<td>3 levels—based on speed and movement complexity</td>
<td>Imitation of whole-body postures with rhythmic full-body movements</td>
<td>Maintain grasp on the controller while imitating movements.</td>
</tr>
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<td>Wii Ware Arcade Games (package)</td>
<td>Players simulate arcade games (pool, air hockey, bowling, or snooker) by moving their arm(s) as they would in the real-world game.</td>
<td>One or both arms</td>
<td>Varies by game; some games are self-paced, while others require movements in reaction to a target.</td>
<td>Upper extremity movement speed, coordination, endurance, and range of motion</td>
<td>Maintain grasp on the hand-held controller and push/release small buttons during arm movements.</td>
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</table>

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<td></td>
<td></td>
<td></td>
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<td>Kinect Sports —Bowling</td>
<td>Players use 1 arm to imitate a bowling swing. Rotating the arm in different ways during the swing can create ball spin.</td>
<td>One arm</td>
<td>Self-paced</td>
<td>Targeted reaching, movement timing</td>
<td>Extend the arm away from the body and direct arm movement toward a virtual target.</td>
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<td>Kinect Sports —Boxing</td>
<td>Players use 2 arms to punch or block opponent punches.</td>
<td>Bilateral arm use</td>
<td>Must react to opponent’s movements. Speed increases with player success.</td>
<td>Movement speed, reaction to target</td>
<td>Perform punching and blocking motions with the arms while dodging and blocking opponent’s movements.</td>
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<td>Kinect Sports —Table Tennis</td>
<td>Players swing 1 arm as if to hit balls as they bounce or fly across the table.</td>
<td>One arm</td>
<td>Must react to opponent’s volley. Speed increases with player success.</td>
<td>Targeted reaching, movement timing</td>
<td>Extend the arm away from the body in a swinging motion in response to a moving target on the screen.</td>
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<td>Kinect Adventures —20,000 Leaks</td>
<td>Players use their limbs, head, and trunk to cover holes and cracks that cause leaks in an underwater tank.</td>
<td>Full body</td>
<td>Must react quickly to new leaks. Speed increases with player success.</td>
<td>Fast-paced forward, sideways, and overhead reaching</td>
<td>Move arms, legs, head, and trunk to plug “leaks” throughout the reachable workspace while standing.</td>
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<td>Child of Eden</td>
<td>Players navigate through space to destroy and avoid targets using arm movements. Different arm movements activate different “weapons” to destroy targets. Both arms raised together overhead creates a large explosion.</td>
<td>Bilateral arm use</td>
<td>Must react to targets as they appear on the screen</td>
<td>Fast-paced forward, sideways, and overhead reaching</td>
<td>Extend one or both arms overhead and away from the body to destroy moving targets on the screen.</td>
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