Introduction

The ability to improve and acquire new motor skills depends on motor learning which is defined as changes in internal neural processes leading to permanent change in performance (Schmidt and Lee, 2011). One way to optimize retention of motor skills is to provide specific frequencies (e.g., continuous, summary, faded) of feedback to the learner on either task performance or the quality of the movement (Klein and Jones, 2008). Virtual reality (VR) training interventions provide an accessible way to deliver standardized feedback to the learner on either task performance or the quality of the movement. This research paradigm can be implemented efficiently as planned with limited adaptation. A child with spastic hemiplegic CP will react positively and successfully complete the intervention.

Objectives

1) Our objective was to determine the feasibility of delivering feedback through a VR system for upper limb skill acquisition in children with CP.

2) Our second objective was to determine if a child can improve and retain upper limb motor skills after a VR intervention.

Hypothesis

1) This research paradigm can be implemented efficiently as planned and proposed with limited adaptation. A child with spastic hemiplegic CP will react positively and successfully complete the intervention.

2) A child will be able to improve and retain their upper limb skills following an intervention.

Subject

One male participant (12 years and 2 months old) with left spastic hemiplegic CP was recruited. The participant had a Manual Ability Classification System score of II out of V and a spasticity level of 1 on the Tardieu scale in the elbow extensors.

Methods

Study Design

Objectives

• Study Design

- Participant had normal sensation (tactile threshold (2.36mm), light touch (20/20) and proprioception (24/24)).
- Normal range of motion

Hypothesis

- This research paradigm can be implemented efficiently as planned and proposed with limited adaptation. A child with spastic hemiplegic CP will react positively and successfully complete the intervention.

Subject

- One male participant (12 years and 2 months old) with left spastic hemiplegic CP was recruited. The participant had a Manual Ability Classification System score of II out of V and a spasticity level of 1 on the Tardieu scale in the elbow extensors.

Methods

Time

<table>
<thead>
<tr>
<th>Measure</th>
<th>Day 1</th>
<th>Day 2</th>
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<th>Day 5</th>
<th>Day 6</th>
<th>Day 34</th>
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<tbody>
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<td>Baseline</td>
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<td>Clinical</td>
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- Kinematic Outcomes

- Clinical Outcomes

- Multiple clinical and kinematic outcomes at three time points (pre, post and follow-up) assessed upper limb movement quality and performance after a 4 day VR intervention involving task-oriented repetitive reaching (see table above).

Outcome measures (continued)

d) Kinematic Outcomes

- Polhemus (Vermont, US) = Electromagnetic tracking system

- Frequency rate: 120Hz; recording time: 10 seconds

- 6 sensors positioned on upper body – Index MCP, mid-forearm, mid-arm, acromion processes (2) and mid-sternum

- Upper Limb Performance Measures: endpoint index of curvature and velocity

- Movement Quality Measures: trunk displacement, shoulder flexion and elbow extension active range of motion.

Results

a) Screening tests

- Participant had normal sensation (tactile threshold (2.36mm), light touch (20/20) and proprioception (24/24)).

b) Clinical Outcomes

- Participant reported that he was highly motivated throughout the intervention.

Figure 1: Time Course of Clinimetric Outcomes

- Clinical Outcomes

- Movement Quality measures: No changes were found for trunk displacement, elbow extension and shoulder flexion variables at pre, post and follow-up evaluations for close, full and far targets.

- Endpoint Performance measures:

- Trajectory Straightness

- Movement Time (ms)

Figure 2: Time course of Endpoint Performance Measures

Discussion

- This case study demonstrates the feasibility of delivering feedback using a VR system in children with spastic hemiplegic CP. The participant was able to complete the intervention as described showing the sustainability of the protocol.

- The participant was highly motivated to participate in the intervention.

- Positive effects of the intervention were indicated by improvements in upper limb performance and movement quality.

- A larger trial is needed to identify which frequency of feedback may optimize motor learning in children with CP.

Acknowledgments

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References