

Designing and Evaluating VR Games for Phantom Limb Pain management

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*Phantom limb pain (PLP) is a type of chronic pain caused by limb amputation, brachial plexus avulsion injury (BPA), or spinal cord injury (SCI).

Research Background

Virtual hands:

mirroring movement of the intact hand through synchronized movement



Ownership: sense that the virtual hands are part of the self

Agency: controlling the movement of the virtual hands and performing a meaningful action

Self-location: feeling the physical body and virtual body are co-located

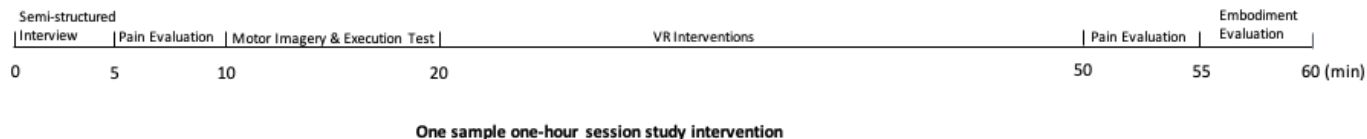


Left: Study participant: Amputee with phantom limb pain;
Right: Basketball Reaching & Shooting Motor Tasks.

Participants: 5 in total: 4 BPA, 1 upper limb amputee.

Study Design: This study was a before-after longitudinal study ([case study/case series](#)).

Procedures:

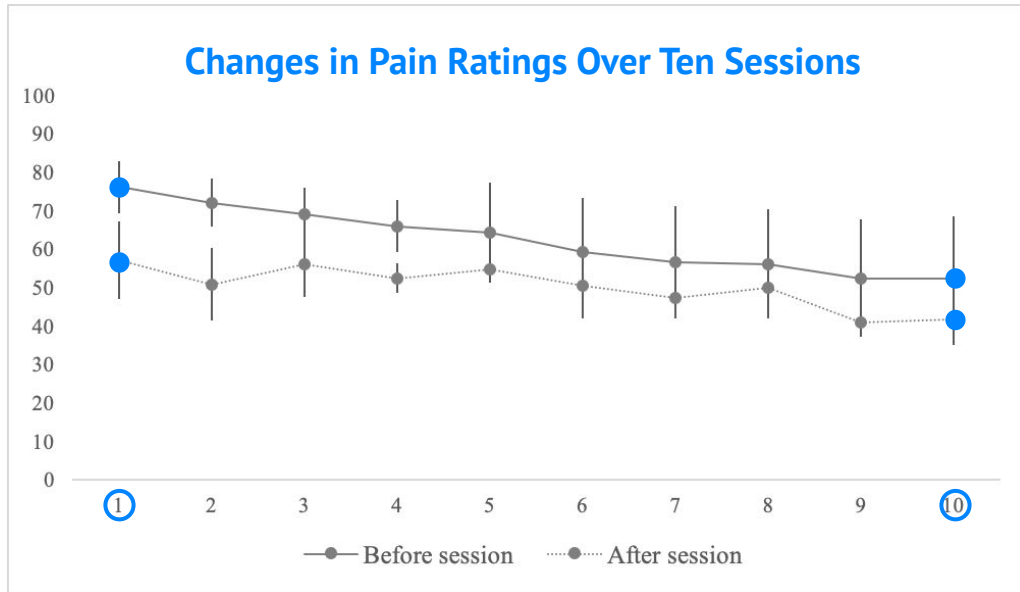


(1) before each session: self-reported pain evaluations via the [McGill Pain Questionnaire](#), Visual Analog Scale (VAS) pain ratings. [Motor imagery movement time](#) was also measured.

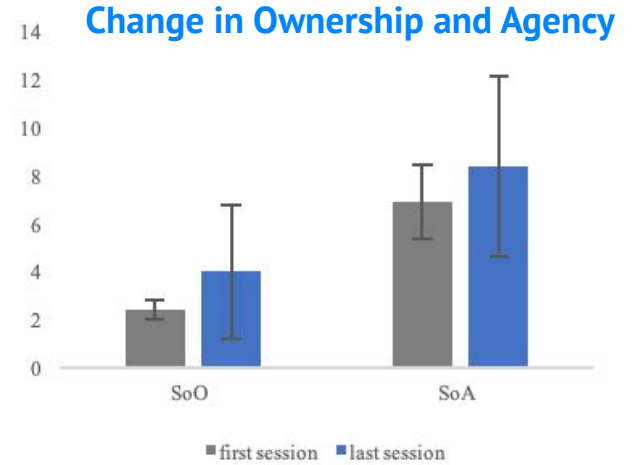
(2) intervention: placement of the VR headset and the controller in the intact hand, and [practice the three intervention tasks in order, each for 5 minutes and repeat twice](#), which includes mirror hand movement and observation, ball-reaching action, and then shooting a basketball action.

(3) after the test, the participants were again asked to fill in their [VAS pain](#) ratings, [embodiment](#) scores (self-reported SoO & SoA).

Results: reduction in pain, increase in SoO & SoA



Mean VAS rating for all sessions: 19.04% (SD = 13.47%). Mean change in VAS for pre-post each sessions/all participants=-21.23% (SD = 15.95%).

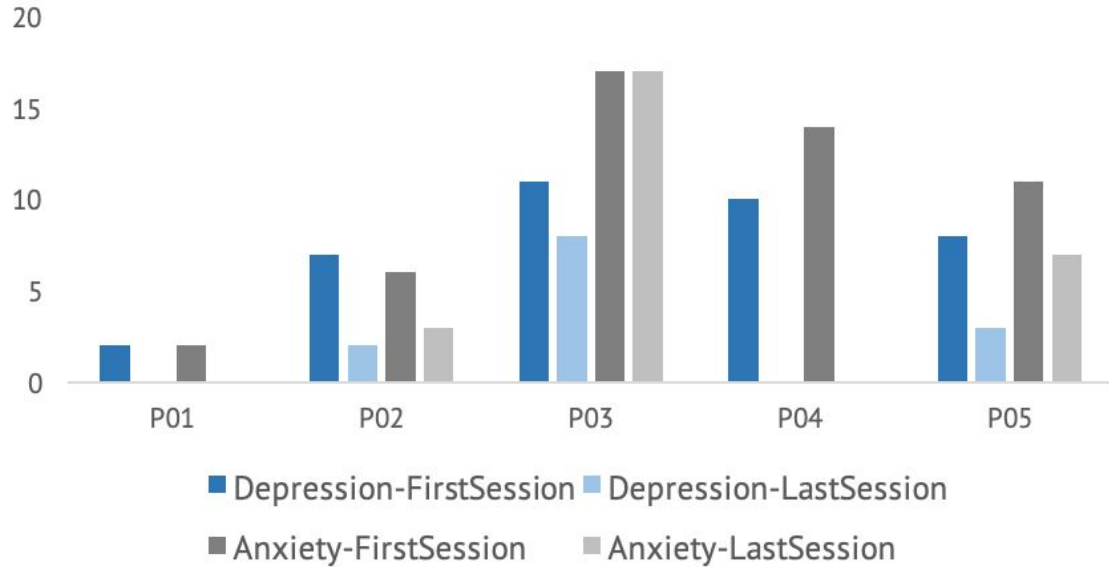


The mean ratings for SoO increased to 4.0, a change of 66.67%.

The mean for SoA increased to 8.4, a change of 21.74%.

Results: I dreamed of my arms moving again!

Changes in Depression and Anxiety Ratings



"I had a dream yesterday, and I saw my right hand and arm moving! It felt so good and so vivid that I can still remember."

Patient 5

Three participants spontaneously reported that after the VR therapy, they experienced dreams where they had complete control of their missing or impaired limbs as they had before their injury.

1. A major limitation of this study is the small sample size. Nevertheless, the findings are encouraging since [all five participants responded with different reductions of their phantom limb pain](#) and associated improvements in anxiety and depression.
2. Very few studies explored the analgesic effect of [multiple VR sessions](#) with more than two or three patients.
3. My study was one of the few that report an improvement of quantitative measures regarding [movements](#) of a phantom limb in VR ([motor imagery](#)).
4. However, correlational analysis between embodiment and PLP were not analyzed due to small sample size. But from the descriptive data, the patients' sense of embodiment improved after the study.