



Evidence in Practice: Current Physical Therapy Interventions for Chronic Pain

Jay Mosesson, PT, DPT
UNC Therapy Services

Objectives

- Discuss therapeutic neuroscience education, guided motor imagery, and other current physical therapy interventions for chronic pain
- Explain background, evidence and applications for visual mirror imagery (VMI) and virtual reality visual mirror imagery (VRVMI)
- Introduce virtual reality as an intervention for low back pain

My Experience



- 19 year old freshman athlete
- Unable to walk without crutches
- Manipulation of a healed, previously fractured, cuboid bone; five months prior to evaluation.
- Steroid injections resulted in more severe pain

My Experience



- Female 64 year old retiree with UE CRPS
 - Male middle aged adult with foot pain,
 - Female college student with low back pain,
 - Female teen with lumbar radiculitis,
 - Female and male student athletes, soccer, football, field hockey, and track; all returned to competition except for one
-
- 11 of 13 patients symptoms abolished in 4-9 sessions
 - All lower extremity patients who could not bear weight on the affected lower extremity left their first appointment fully weight bearing.

Introduction

- Current trend in treatment of chronic pain: restore normal pain processing
- Therapeutic neuroscience
- Guided motor Imagery
- Visual mirror imagery
- Virtual reality



Therapeutic Neuroscience Education (TNE): Adriaan Louw PT, PhD CSMT



- Explain pain
- Explain fix and time to recover
- Avoid mechanistic explanations
- Deemphasize nociceptive input
- Exercise and Sleep
- Meditate

Graded Motor Imagery (GMI): Lorimer Moseley. PT, PhD

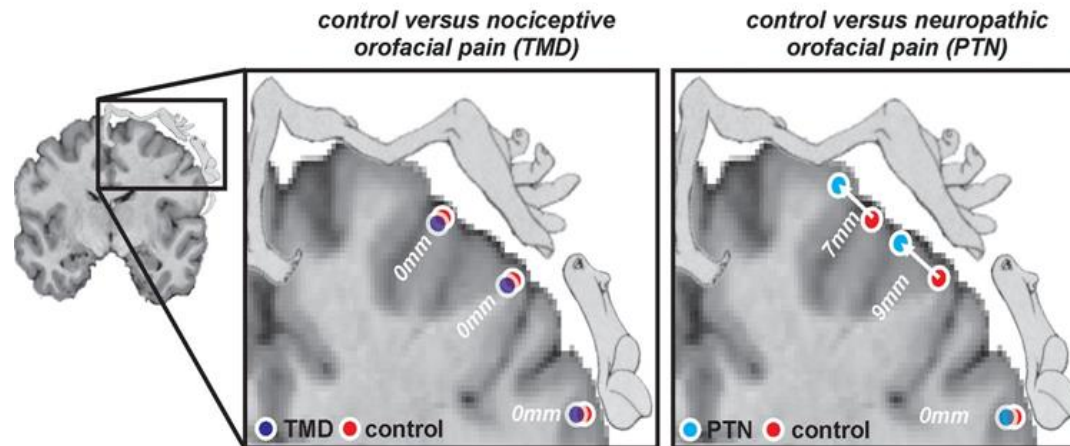
- Three interventions, two weeks for each: supported by research
- First: Right and left recognition
- Second: Visualize
- Perform; mirror therapy (VMI)



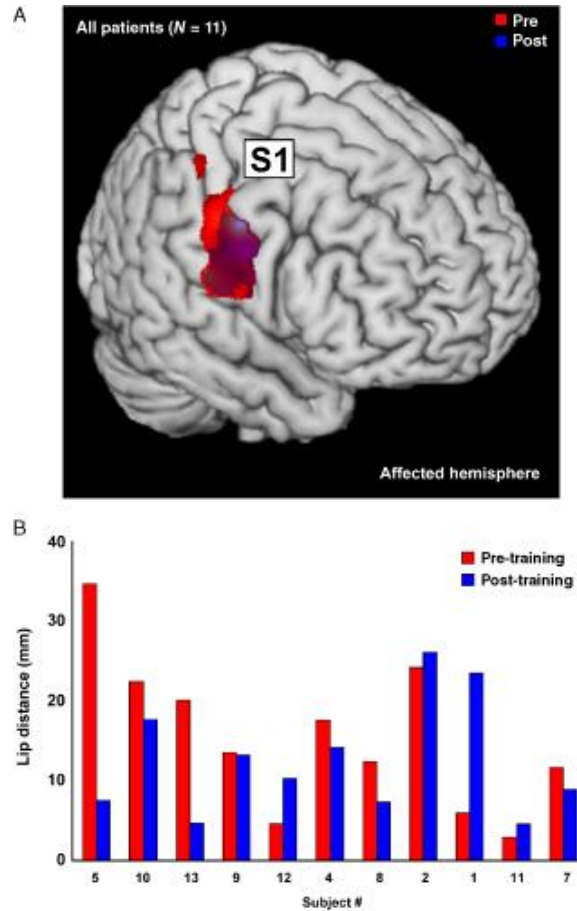
LATERALITY

- Right or left movement of direction difficult in chronic pain patients (Bowering, Bulter & Moseley, 2014; Cately O'Connell, Berryman, Ayhan & Moseley, 2014, Reinersmann et al., 2011)
- Overlap of body representation in homunculus (Foell et al., 2014; Henry, Chiodo, & Yang, 2011)

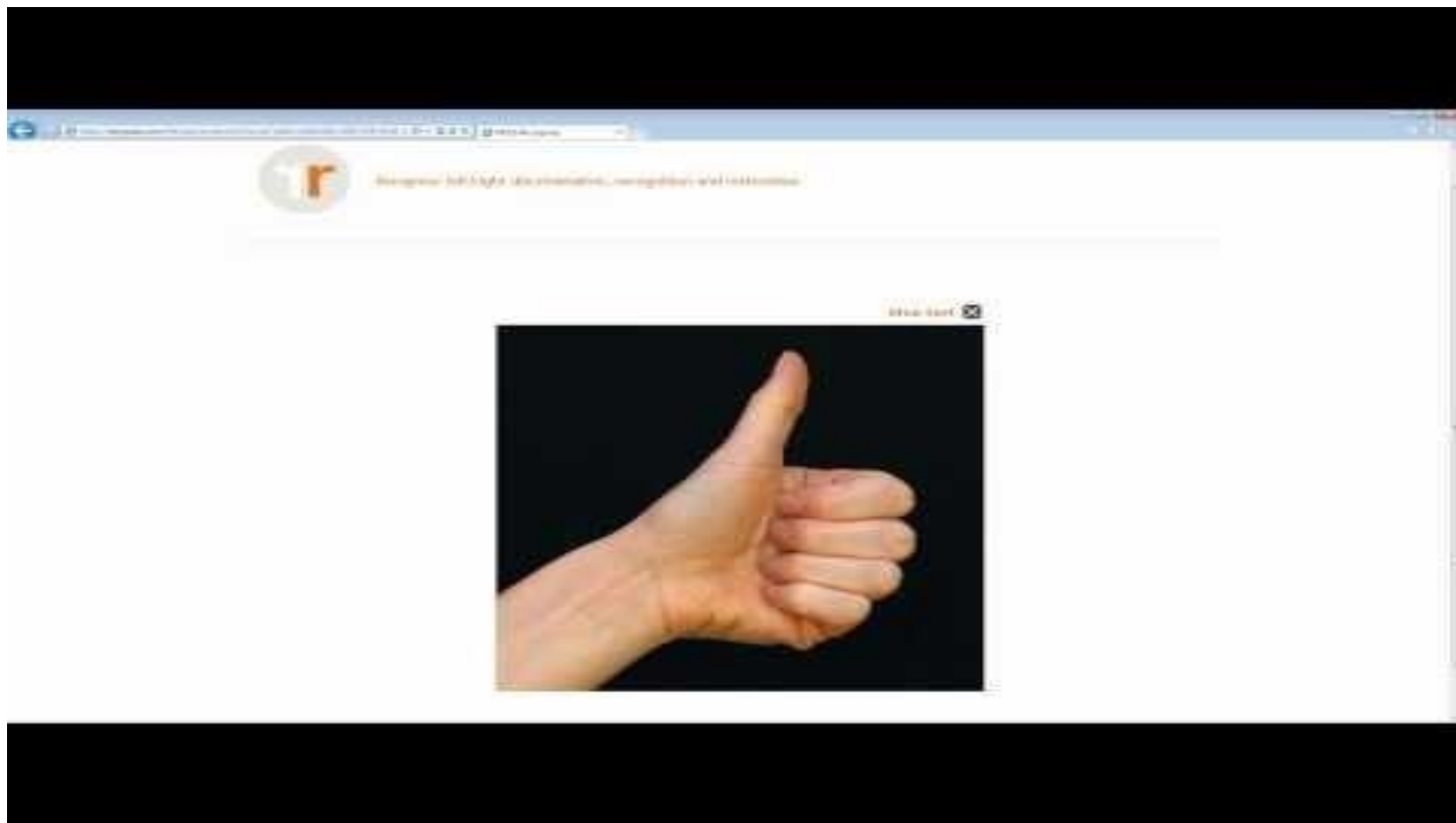
SI organization and chronic pain



Mirror therapy for phantom limb pain: Brain changes and the role of body representation



Recognize Flashcards



Visual Mirror Feedback (VMF)



Moving an uninvolved extremity simultaneously with a visually obscured contra-lateral afflicted extremity, while viewing a mirror image of the uninvolved extremity.

Visual Mirror Feedback

- Ramachandran et al (1995)

Amputees

Actual mirror or researchers hand

Phantom hand pain abolished

- McCabe et al (2003)

CRPS

Effective for disease durations

Six weeks to one year

- Cacchio et al (2009)

CVA and CRPS

Increased speed, decreased pain

- Moseley (2006)

GMI for CRPS, Brachial Plexus Avulsions and CRPS

More effective than traditional PT& medical management

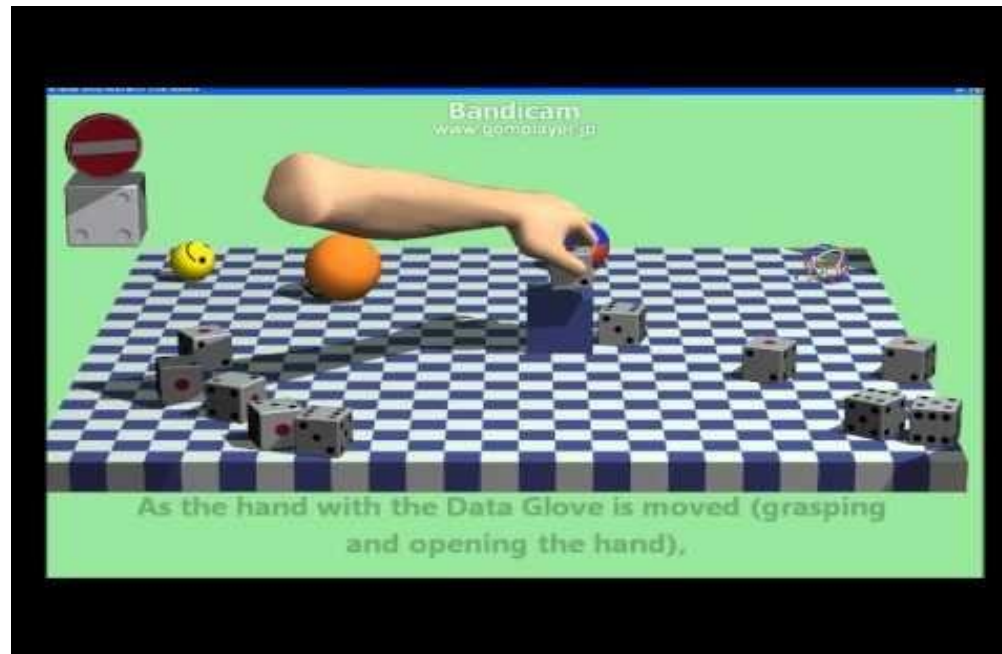


VMF Study Limitations

- Causes of CRPS , ages and other demographics varied
- Subject population varied
- Effect sizes not reported
- Unable to generalize to specific population
- Retests not performed
- Measurement methods for success varied
- Inclusion criteria varied

Virtual reality visual mirrored feedback

- Virtual limb or virtual body avatar to simulate pain free motion. The virtual moving avatar or body part was either viewed on a screen or in virtual reality goggles.

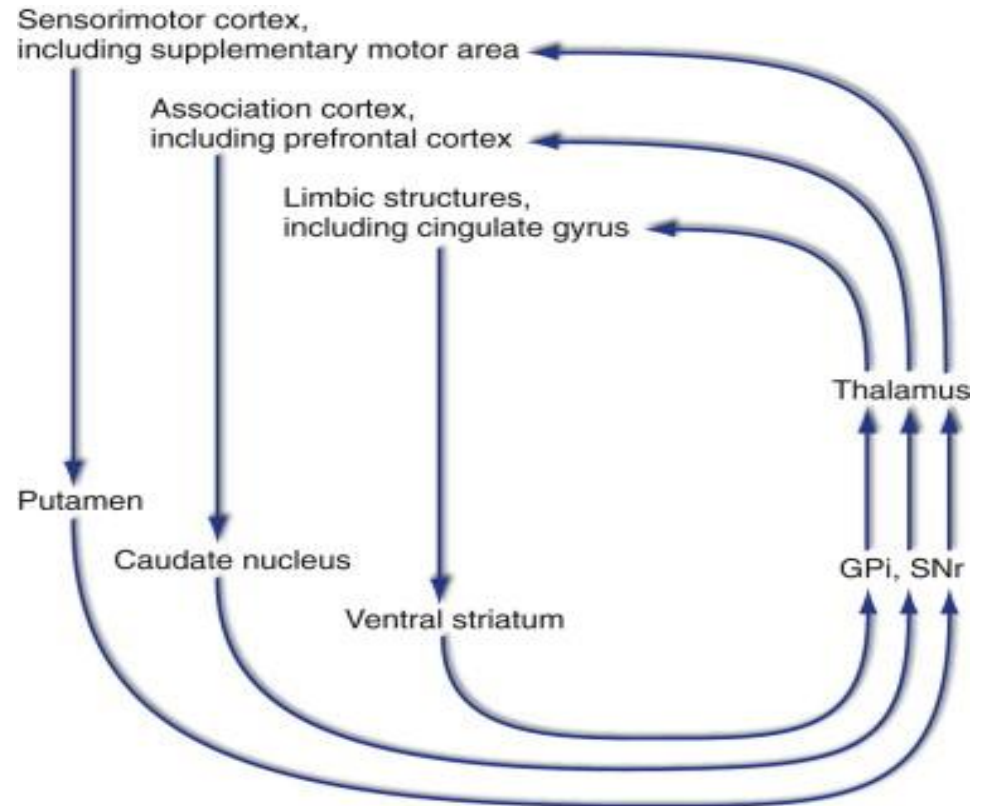


Virtual VMF Studies

- Pennelle et al (2012); Sato et al (2010)
VRVMF effective in reducing CRPS pain when used instead of a mirror
- Cole, Crowle, Austwick, & Slater (2009); Murray, Patchick, Pettifer, Howard, & Caillette (2006); Penelle, et al. (2012).
VRVMF effective in reducing phantom limb pain
- Won and Collins (2012)
Reduces facial pain
- Diers et al (2014)
VRVMI stimulates same brain areas as VMI

fMRI; Movement and Pain

- Baliki (2012);Geha (2008)
- Globus palidus
- Caudate Nucleus
- Sensory Cortex S-1
- Motor Cortex M-1
- Motor Association (SMA)
- Parietal Lobe
- Insula
- Midbrain PAG



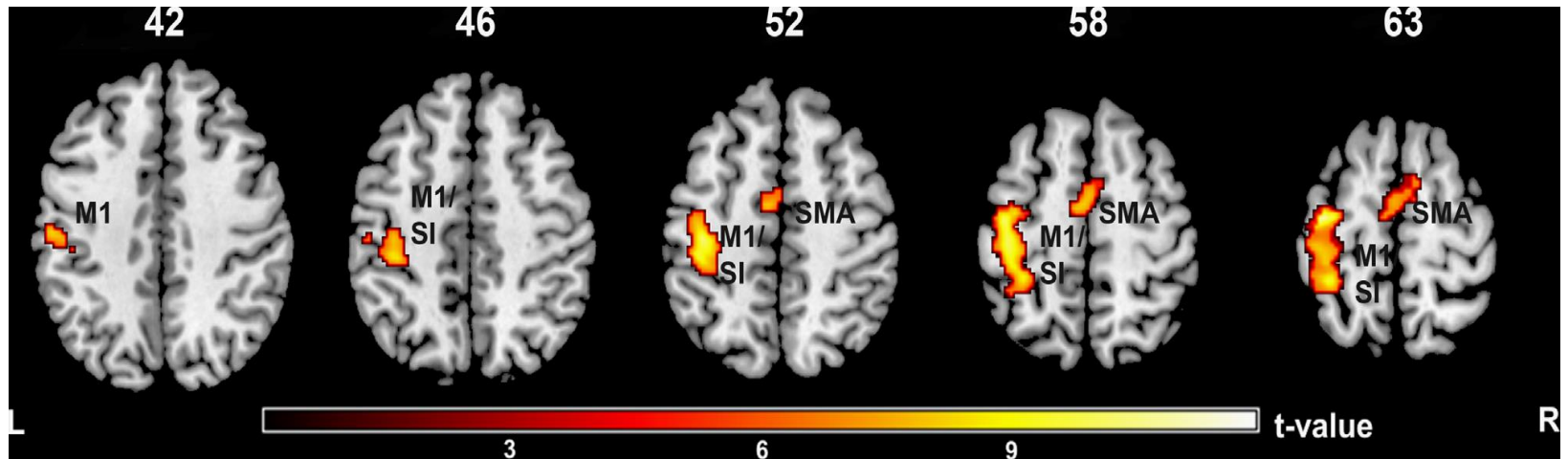
Nolte, J. (2010) Essentials of the human brain
electronic resource pp149

Brain activation during VMI

Regional blood Oxygenation level dependent response (BOLD)

- Diers et al. (2015). fMRI during VRVMI or VMI
- To compare VRVMI to VMI
- Healthy subjects, wireless fiberglass sensor right hand. Goggles used for virtual reality. VR environment included, body under blanket, MRI scanner room
- Open and close right hand: MRI and VMI conjunction
- Left, S-I, M-I, S-II, superior temporal gyri, insula., Right M-1, SMA Bilateral medial temporal gyri
- Increased communication with S-1/M-1 of moving hand to S-1 of visualized hand.

Brain Activation during VMI



Conclusion: The connection between the intact motor area of the brain and the visual area of the contralateral aberrant somatosensory area of the brain results in normalization of the body image representation in the aberrant primary motor cortex

- Illusion-related brain activations: A new virtual reality mirror box system for use during functional magnetic resonance imaging. *Brain Research*, 1594, 173-182. doi:10.1016/j.brainres.2014.11.001 [doi]

My Protocol

- 1) Mirror box or mirror
- 2) Move intact joint only with contralateral painful joint obscured; Visualize contralateral part moving painlessly and unobstructed (Moseley, phase II)
- 3) Then also move painful joint
- 4) Most painful joint, most painful motion, successfully less painful motion, less painful joint after each motion becomes pain free
- 5) Progress to painful multi joint activity using me as mirror
- 6) Go back to beginning if motion becomes painful
- 7) Progressive loading

VRVMI for Chronic Low Back Pain

- Similar physiological changes as CRPS (*Baliki et al, 2011, Geha et al. 2006, Cohen & Mao, 2014; Linnman, Becerra, & Borsook, 2012*).

reduced grey matter in the right nucleus accumbens, right insula, and left sensory motor cortex.

astrocyte, microglia, and lymphocyte releases of inflammatory cytokines

- No pain free separate contralateral joint
- No studies in literature

VRVMI for Chronic Low back pain

- Feasibility Study (Rooslink, et al., 2015)
- Used motion capture suits , avatar, on a screen
- Good immersion based on Presence Questionare
- Conclusion that VRVMI could be effective for back pain



Real-time modulation of visual feedback on human full-body movements in a virtual mirror: development and proof-of-concept. *Journal of NeuroEngineering and Rehabilitation* 12(2), 1-10.
doi: 10.1186/1743-0003-12-2

VRVMI for Chronic Low Back Pain



Conclusion

- Current physical therapy interventions are research based and stress normalization of aberrant pain processing. NTE, GMI, VMI, and VRMI are among these
- VMI and VRVMI work because of neural connections in the midbrain and brain between movement, emotion, and pain
- Physical Therapist are uniquely qualified in the use of movement and visualization therapies because they specialize in the science and treatment of body movement impairments
- Modern physical therapy interventions are evidence based, cost effective, and work