

# Mirror, Mirror

Reflections on using mirror feedback in stroke rehabilitation

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# Disclosures

**This course was designed to support and study the implementation of evidence into practice**

**We intend to use this material in future research**

**Feel free to share all materials with attribution**

# What is mirror therapy?

**Mirror imagery**

**Mirror visual feedback**

**Mirror augmented feedback**

**A component of graded motor imagery**

What



**Mirror therapy:** Use of the mirror image of an unaffected hand to provide perceptual inputs representing the affected hand

# Mirror (box) therapy or mirror visual feedback:

**simply looking at the image** [visual stimulation, motor preparation]

**movement/stimulation of UNAFFECTED SIDE** reflected in the mirror [action observation = motor stimulation]

**sensory stimulation of AFFECTED SIDE** behind the mirror [synchiria]

**bilateral movements with the target limb behind the mirror**  
[motor practice] (McCabe, 2011)

## Mirror (box) therapy or mirror visual feedback:

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[motor practice] (McCabe, 2011)

## Graded motor imagery:

a formal, sequential program of laterality judgements [deciding if image is

left or right: motor preparation], mental imagery [motor stimulation] and

mirror visual feedback [motor stimulation → motor practice] used for **pain**

**syndromes**

(Moseley, 2004)

# Motor imagery



mental rehearsal or simulation of an action or activity without any body movement (Harris & Hebert, 2015)

**AKA imagined movements**

inherent focus is on the kinesthetic sense of movement

**Motor stimulation paradigm**



# Mental imagery

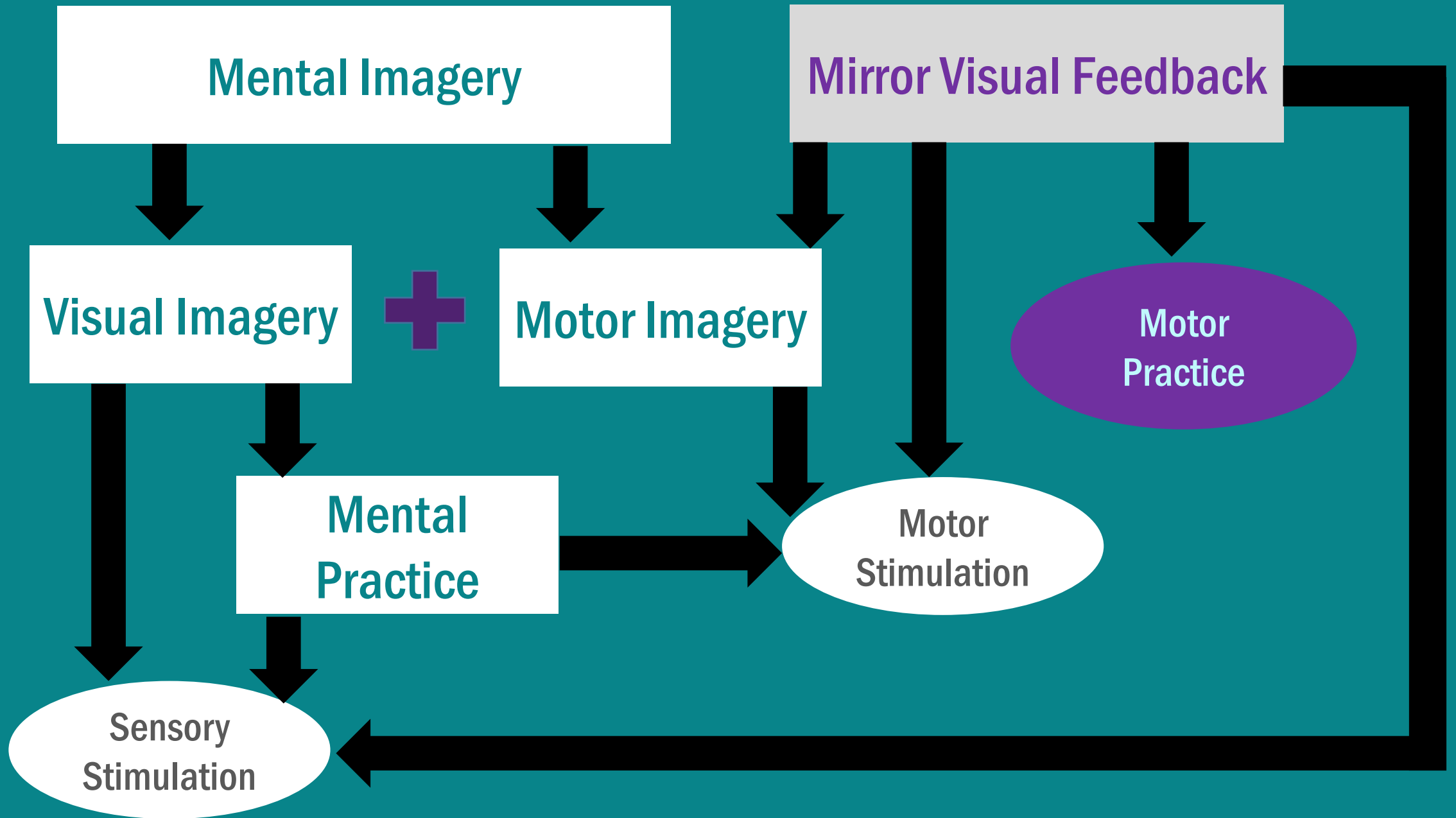
**A perceptual experience in the absence of an actual external stimuli**

**Can include multiple forms of sensory representation: touch, sight, smell, and sounds**

(Schmaltzl et al, 2013)

**Imagined movements are a subset of mental imagery [motor stimulation]**

**Other forms of mental imagery include guided visualization and hypnosis**





# Other constructs to consider

## Functional equivalence

careful matching of motor imagery elements to desired action to stimulate the same brain areas & strengthen the memory trace of the task

## Bodily illusions

deliberate manipulation of perception of physical aspects of body size, shape or position, tactile & visual representation

(Boesch et al, 2016; Moseley & Weich, 2009)

# Other constructs to consider

## Cortical reorganization

alterations in the function of the somatosensory cortex leading to OR resulting from distorted or altered perceptual feedback

(H. Flor, C. Maier)

## Action observation

stimulation of the motor networks by observing movement

(Larsen et al, 2019; Zult et al, 2016)

## Cross education

preservation of strength in protected/immobilized muscles by targeted resistance training of contralateral side

(Green & Gabriel, 2018; Zult et al, 2015, Magnus et al, 2013 )

# Why would I use mirror imagery with my clients?

## Sensory factors

Pain

To augment loss of proprioceptive input

Multisensory input to augment feedback



Why

# Why would I use mirror imagery with my clients?

## Sensory factors

Pain

To augment loss of proprioceptive input

Multisensory input to augment feedback

## Motor factors

To assist in recruitment of weak muscles

To augment feedback during motor practice

To support motor learning

To optimize cross-education



Why

# How does it actually work?

**Changes in somatosensory processing and cortical activation**

- **Where the signals travel (representations)**
- **How they interact with other signals (activation patterns)**
- **How the brain remembers & localizes (maps)**
- **How the body responds (physically and physiologically)**

Why

# Theoretical underpinnings

**Sensorimotor incongruence?** Visual & motor networks are separate in the brain (McCabe, 2011)

**Body perception & ownership?** Correction of disrupted body schema? (Lewis & Schweinhardt, 2012)  
Unlearning 'learned paralysis' or motor extinction?

**Mirror neuron system ?** Activation of a neuroanatomical link between visual stimuli and motor neurons (Hendy & Lamon, 2017)

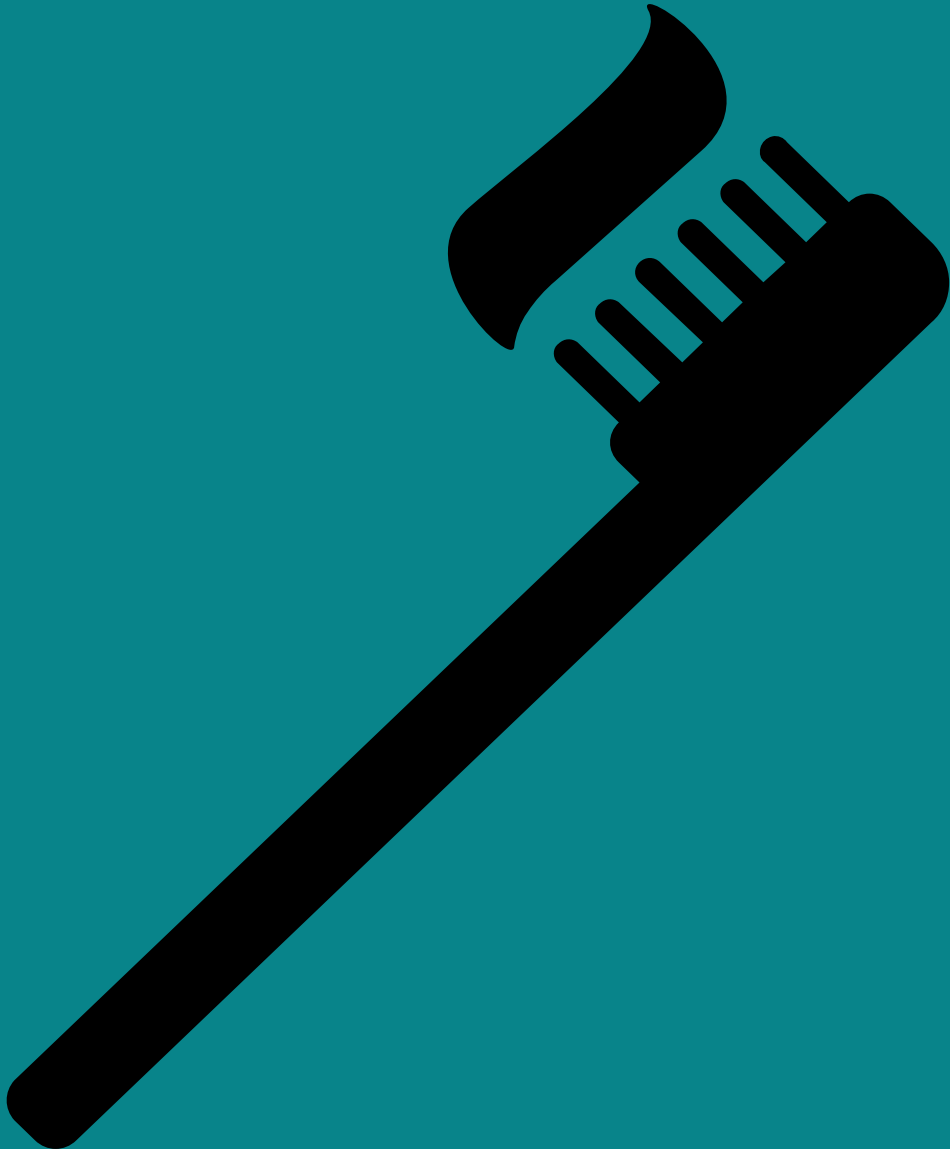
**Bilateral coupling of both arm movements ?** Activation of visual-motor cortex → pre-motor cortex → motor and somatosensory cortices → cerebellum and cross-hemisphere communication (Arya, 2016)



**Theories** are like  
toothbrushes...

Everyone has one, and  
nobody want to use anyone  
else's

(Source unknown)



# Current evidence: syntheses

## **Stroke** (motor function)

Rothgangel et al, 2011

Pollock et al, 2014

Zeng et al, 2018

Luo et al, 2020

Theime et al, 2012, 2018

Perez-Cruzado et al, 2017

Lin et al, 2019

Saavedra-Garcia et al, 2021

# Overview of syntheses

	Population	Questions	Study characteristics	Findings
Rothgangel et al, 2011	Stroke, CRPS, PLP	Clinical effects of mirror therapy	All study designs, n=21 papers (8 addressed stroke)	Low quality, lack of clarity about who will benefit and how to implement
Theime et al, 2012, 2018	Stroke	Effectiveness of MT after stroke	RCTs or crossover RCTs n=62; N=1982 persons	Moderate quality evidence ↑ motor function; low QE for ↓ pain, unclear QE for visuospatial neglect
Pollock et al, 2014	U/E stroke	Effectiveness of interventions for upper limb function	40 reviews including 503 studies and N=18K participants	Moderate quality evidence for mirror therapy as well as CIMT, mental practice, sensory interventions and VR
Perez-Cruzado et al, 2017	U/E Stroke (both acute and chronic)	Superiority of MT to other interventions	15 studies met minimum quality inclusion criteria	MT is better than conventional rehab with a range of effect sizes, but combining with CR and other modalities is ideal Shorter sessions are better than long, but motor gains do not necessarily translate to increased ADL function in chronic stroke

# Overview of syntheses

	Population	Questions	Study characteristics	Findings
Zeng et al, 2018	U/E stroke	Effectiveness of MT compared to other interventions	11 RCTs (N=347)	Moderate effects for MT improving motor function but variability in results not clearly due to sample sizes, duration of MT or acuity of stroke
Lin et al, 2019	Stroke <6mos	Effective treatments for improving motor function (U/E and L/E examined separately)	129 studies including 7450 participants looking at 18 different treatments (incl MT)	MT was effective (U/E > L/E) Of note, task-specific training & e-stim were also endorsed for U/E and VR for L/E BUT little evidence for <b>superiority</b>
Luo et al, 2020	Stroke (any limb as target, any timing)	What is the best treatment to combine with MT?	10 trials, n= 444	Combining MT with e-Stim, EMG biofeedback, acupuncture or a sensory feedback with a mesh glove all improve effects (modestly)
Saavedra-Garcia et al, 2021	U/E stroke	Is e-stim + MT better than just MT or just e-stim or conventional therapy	7 trials, N=314 participants	Based on good quality papers, no difference on upper limb motor function (Fugl-Meyer, Box & Block) but high certainty evidence for substantial gains in the Action Research Arm Test

# Overview of syntheses

	Population	Questions	Study characteristics	Findings
Tosun et al, 2025	Stroke	Does mirror therapy help spasticity?	12 RCTs, n=417	Small but significant effects across studies for both upper and lower limb spasticity (modified Ashworth Scale)

# Current evidence: pearls from single studies

## Stroke (motor function)

### Yoon et al, 2014

Can combine CIMT and MT for patients with subacute stroke

### Lundquist & Nielsen, 2014

Left/right judgement does not influence the effect of MT after stroke

### Lim et al, 2016

MT is better when functional tasks are used

### Simpson et al, 2019

Mirror therapy + cross education for L/E rehab is feasible and demonstrated superiority to cross education in improving walking velocity with chronic stroke clients (>1yr post)

### Ehrendberger et al, 2019

Mirror therapy + cross education for U/E rehab isn't effective when done for 4 weeks with chronic stroke clients 3x/week

### De Sire et al, 2025

Mirror therapy vs CIMT for U/E: both groups improved, CIMT might help more with strength (trend)

## FIGURE 2

### Unilateral Strength Training and Mirror Therapy in Patients With Chronic Stroke: A Pilot Randomized Trial

Ehrensberger et al

American Journal of Physical Medicine & Rehabilitation  
98(8):657-665, August 2019.

doi: 10.1097/PHM.0000000000001162

**Mirror and strength training group  
participant set-up.**

**The mirror is highlighted with red markings.**



# Canadian Best Practice Guidelines for Stroke Care

Section 5.1: Recommendations on management of the upper extremity following stroke—General principles and therapies

(ii) Following assessment to determine if they are suitable candidates, patients should be encouraged to engage in **mental imagery** to enhance upper-limb, sensorimotor recovery (Evidence Level: **Early-Level A**; Late-Level B).

(v) **Mirror therapy** should be considered as an adjunct to motor therapy for patients with very severe paresis. It may help to improve upper extremity motor function and ADLs (Evidence Level: **Early-Level A**; **Late-Level A**).

(2019 update)

# Canadian Best Practice Guidelines for Stroke Care

## Section 8: Recommendations on rehabilitation of visual perceptual deficits

(ix) Mirror therapy appears to improve neglect (Evidence Level B) and may be considered as an intervention for unilateral inattention (Evidence Level B).

(x) Combining mirror therapy with limb activation appears to be more effective than limb activation alone at improving neglect (Evidence Level B).

(2019 update)

# Contraindications to mirror visual feedback

Vision impairments (acuity)

Profound hemi-neglect



Unhelpful responses to MT

Reports of nausea or vestibular responses (i.e. dizzy, off-balance, falls or fear of falling)

Negative changes in limb temperature or weight

Pain invoked or increased

# Consider using Mirror Therapy for:



Motor (re) learning

Supplementing loss of  
proprioception

Sensory retraining

Pain

Neglect



# **Incorporating Mirror Therapy into Home & Clinic programs**

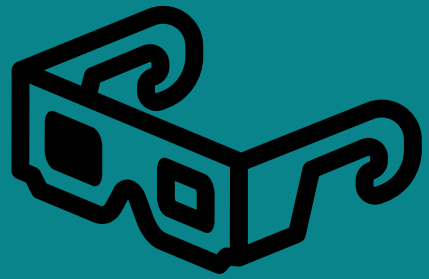
# Set-up is critical to success

**Quiet environment to start**

**Seated comfortably where both arms can rest on the surface with the mirror box OR with a large mirror positioned at midline**

**The mirror box may need to be slightly angled to optimize their ability to see in the mirror**

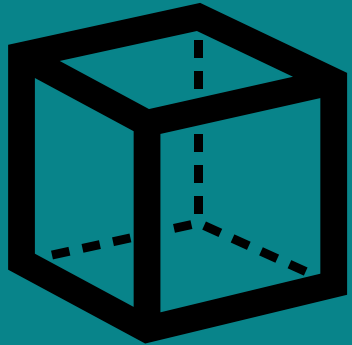
# Test for the illusion:



do they feel like they are

looking **through** the mirror ?

# Try a couple of short sessions in the clinic:



Can they concentrate?

Do they get any pain?

Does it make them dizzy or queasy?

Do you see a response inside the box?

# Your turn...

**Give it a try!**

**Consider: optimal positioning for arm support and visualization**

**Getting the illusion – do you? How long does it take?**

# Practical advice for implementation



# Grading and progressing: PATTLEP

**Sport model for imagery** (see Harris & Hebert, 2015)

## Physical

practice, positioning, NMES, intensity, facilitation by therapist

## Environment

reduce distractions, visual / auditory cues and feedback

(vanVliet & Wulf, 2006)

promote relaxation?

When & How

# Grading and progressing

## Task

object interactions, multisensory inputs

isolated movements vs. functional activities

## Timing

before or after physical practice?

Increasing dose & duration

When & How

# Grading and progressing

## Learning

Grading the task relative to mastery

## Emotion

Meaningful tasks, client choice/preference

## Perspective

Action observation vs. bilateral movement

Internal focus on bodily movement and limb position vs external focus on control/manipulation of objects (Harris & Hebert, 2015; vanVliet & Wulf, 2006)

When & How

# Distortions



Fatigue

Falls risk

# Complimentary modalities to Mirror Therapy

**Motor imagery, mental imagery**

**Relaxation**

**Virtual reality reflection therapy (e.g. iPad camera)**

**NEMS: combined therapy**

**Augmented tactile feedback**

Synchiria

Bilateral sensory stimulation

*Localization, direction of stimulus*

*Mindful experience of stimulus*

**When & How**

# 'Reflective' Summary

**MT is helpful for upper extremity (re)training in both orthopedic and neurological conditions**

**Mirror visualization (action observation) is good for pain AND possibly as adjunct to cross-education**

**Mirror augmented bilateral training most effective when task-based**

**An alternative to conventional rehab if pain is a barrier**

**Sessions should be between 20-30 minutes for motor practice; shorter repeated sessions may be better for a painful limb**

**Daily practice is ideal – minimum number/week unknown, #/day unknown**

**When & How**

# Client education and home programs

Education is key to achieving an effective dose and duration of MVF; may need to engage family members as well

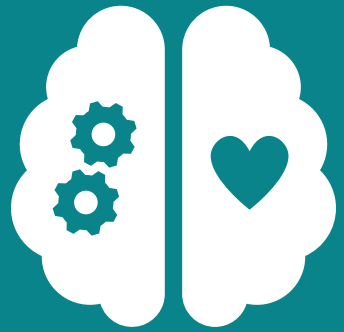
May need to understand some basic principles to get 'buy in'

Pick the examples and stories that work for you, and rehearse them, construct educational materials that utilize them, and reinforce regularly

Athletes use motor imagery to practice and train

Motion-sickness as an example of a sensory-mismatch

When & How



# Mirror therapy for motor retraining

# Minimal active motion available

## Action observation

stimulation of the motor networks by observing movement

(Larsen et al, 2019; Zult et al, 2016)

Observation of the unaffected arm in the mirror  
Conscious attention to the movements of others  
Helpful for pain reduction

## Cross education

preservation of strength in protected/immobilized/weak muscles by targeted resistance training of contralateral or unaffected side

(Green & Gabriel, 2018; Zult et al, 2015, Ehrensberger et al, 2016)

Resistance training of unaffected arm while watching in a mirror  
Match to early recovery targets and key functional motions

# Gross active motion available

**Bilateral simultaneous activity = mirror augmented motor practice**

**Reduces co-contraction**

**Bilateral access**

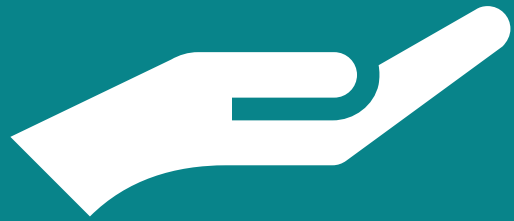
**Augment proprioceptive feedback**

**Best if task-based, not exercise-based**

# Refining motions

**Use with GRASP  
components**

A decorative graphic on the right side of the slide, consisting of three stacked, horizontal purple bars of increasing height from left to right, creating a stepped effect.



# Mirror therapy for sensory retraining

# What if sensation is very poor ?

**Augment the feedback (*cross-modal inputs*)**

**Weight**

**Texture**

**Colour to increase visual attention**

**Perception of temperature (*i.e metal feels cool*)**

**Auditory elements (*crackling, squeaking*)**

**Proximal inputs when possible**

**Speed of stimulus (*longer, slower*)**

# What if the person has allodynia or other sensory gain?

**Mirror visual feedback has been shown to be effective in post-stroke CRPS** (Smart et al, 2016)

**Direct stimulation of the area of allodynia is likely to increase pain, not decrease it** (Spicher, 2006)

Work proximally in an area of dysesthesia or hypoesthesia

Progress towards the area of allodynia

Reduce all direct inputs temporarily

# Proprioceptive retraining

**Weight-bearing on a ball or balloon**

**Rolling a cylinder with hand or foot**

**Practicing joint position exercises (duplicating pictures)**

**Motor imagery**

**Stretchy tape for augmented cutaneous feedback**

(Harris & Hebert, 2015; Hagert, 2010; Valdes et al, 2014)

# 'Reflective' Summary

**MT is helpful for promoting motor and sensory recovery after stroke**

**Mirror visualization (action observation) is good for pain AND possibly as adjunct to cross-education**

**Mirror augmented bilateral training most effective when task-based**

**Think multi-modal for combining sensory and motor effects**

**An alternative to conventional rehab if pain is a barrier**

**Sessions should be between 20-30 minutes for motor practice; shorter repeated sessions may be better for a painful limb**

**Daily practice is ideal – minimum number/week unknown, #/day unknown**

**Resources available at : [https://drive.google.com/drive/folders/1-9Ze2V\\_68-jVApRosHHZi01PQUpKZun?usp=sharing](https://drive.google.com/drive/folders/1-9Ze2V_68-jVApRosHHZi01PQUpKZun?usp=sharing)**

Find the video links and patient education resources here:

[https://www.dropbox.com/scl/fo/23bx5ly2zjnm6ipcahxxz/AKzP\\_KX3UAesqKab0tqcxJk?rlkey=k71lrxt097bg9csljxa85vd49&dl=0](https://www.dropbox.com/scl/fo/23bx5ly2zjnm6ipcahxxz/AKzP_KX3UAesqKab0tqcxJk?rlkey=k71lrxt097bg9csljxa85vd49&dl=0)

OR Scan this code:



# LET'S TALK!

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