Mirror, Mirror in My Brain: 
Graded Motor Imagery to Improve Clinical Outcomes

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Workshop aims

Following completion of this lecture, the participant will be able to:
• Describe some of the basic science underpinning the use of GMI, including: neuromatrix paradigms, bio-plasticity, mirror neurons and dynamic representation of the body
• Explain elements of GMI in a way that is understandable for both clinicians and patients
• Discuss use of implicit and explicit motor imagery, mirror therapy and graded exposure in the context of a rehab program

What is GMI?
Graded Motor Imagery

• A graded approach for treating pain

Left/Right Discrimination

• Brain-based discrimination exercise to identify alterations to body schema/representation, work “under the radar” in movement systems when physical movement is too impaired or too painful

Workshop outline

Stephen Schmidt – hour 1
• What is GMI
• Modern neuro-immune notions of pain & the neuromatrix
• Body maps, representation and schema
• Graded exposure and pacing applied to GMI
• Review of evidence

Robert Johnson – hour 2
• Biopsychosocial perspectives on pain
• Practical application of GMI related to:
  • Implicit motor imagery or L/R discrimination
  • Explicit motor imagery
  • Mirror therapy
  • Conceptual change and training progression

Acknowledgements & disclosures

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www.noigroup.com
www.noijam.com
www.gradedmotorimagery.com
www.bodyinmind.org
Motor imagery

• Thinking about moving without actually moving

Mirror therapy

• Therapist as illusionist – retraining the brain to re-experience what the problematic body part should look/feel/move like (as applicable)

GMI: Who’s it for?
• Peripheral neurogenic presentations
• Neuropathic & central sensitized
• Neurologic/rehab population
• Chronic pain states
• The “immobilized”?
• Acute states?
• Who’s it not for?

GMI and brain stuff...

• Anytime you start talking about the brain (esp. related to persistent pain) what does the patient think?
• In order to foster a healthy therapeutic environment, it is key to explain the process in a way that is easy for the patient to understand and follow

got pain?

~30% of the population in the USA experience an ongoing pain state*

Pain without apparent biological value persisting beyond expected healing time (generally >3-6 months)

“It is inherently ridiculous to consider pain as an isolated entity”

– Patrick Wall (1999)

A call for more understanding

“We suggest a need for a better understanding of the basic science of pain mechanisms…”


What is pain? Emerging ideas...

Pain is a multiple system output, activated by an individual's specific pain neural signature. The neural signature is activated whenever the brain concludes that the body tissues are in danger and action is required.

Melzack R (2001) Pain and the neuromatrix in the brain - J of Dental Ed
Moseley GL (2003) A pain neuromatrix approach... Manual Therapy

Common pain neurosignatures

Spinal cord:
- Basic processing, switchboard

Thalamus / hypothalamus:
- Stress response, ANS, motivation

Sensory cortex

Premotor & motor cortex:
- Movement preparation & response

Cerebellum:
- Movement response

Amygdala:
- Fear, addition, conditioning

Hippocampus:
- Memory, spatial recognition

Insula & cingulate cortex:
- Concentration, attention

Prefrontal cortex:
- Problem solving, memory

(e.g. Flor H, Budimlll MC, Casey KL, Petrovic P, Ingvar M.)

A pain neurosignature:

– Patient with low back pain and radiculopathy during an anterior pelvic tilt


Processed in the brain, expressed (and referenced) in the body

[Images and diagrams related to pain neurosignatures and brain anatomy]
Plastic maps!
- Biologically coded, but environmentally sculpted
- Braille readers
- Local anesthetic
- Rapid changes with practice
- Maps can even take on non-organic parts and represent the space around you

Cortical-body matrix
- A body-centered multisensory representation of our body and peripersonal space

- Cognitive-evaluative
- Motivational-affective
- Sensory-discriminutive
- Body-self perception
- Action programs
- Stress-regulation

Plasticity and injury

- Phantom takeovers
  - Amputation
  - Nerve injury
  - SCI
  - CNS injury
- Focal dystonia, RSI, CTS, CRPS
- Chronic LBP, knee OA, chronic pain, etc.

“Smudged” representations

- Size/resolution/orientation?
- Discrimination ability with “intact” sensory testing (complex sensory impairment)

“Can’t find it!”

- Sensory dysfunction also relates with motor dysfunction

Body representation

Body schema, image, ownership, awareness, self-perception, etc.

- Terms are often debated, have overlap and are appreciated in distinct ways by various disciplines
- *For simplicity... will describe it as the brain’s dynamic representation of the body:*
  - sculpted by exteroceptive and interoceptive experiences
  - modulated by beliefs, memory and psychosocial factors
  - guided by plastic body maps

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Moseley (2008) Pain

Luomajoki & Moseley (2009)

Lotze & Moseley (2007), Bray & Moseley (2011)
Disorganization of body representation

Assumption: accurate body representation underpins skilled movement, sensory localization & discrimination, etc.

Chronic pain appears to be associated with disruption of body-related cortical representations

(Moseley & Flor, 2012)

Where does brain plasticity fit?

<table>
<thead>
<tr>
<th>Features</th>
<th>Interventions</th>
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<tbody>
<tr>
<td>↓Endurance</td>
<td>Deep stabilizer training</td>
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<tr>
<td>↑Fatigue</td>
<td>progression, motor control, graded progression</td>
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<td>↓Strength</td>
<td>of targeted exercise</td>
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<td>↓Muscle coord.</td>
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<td>↓Proprioception</td>
<td>Repositioning accuracy</td>
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<td>↑Pain</td>
<td>Manual therapy &amp; pain relieving procedures</td>
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<td>↓Range of motion</td>
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Addressing the impairment  Vehicle to change the brain

What about the other groovy stuff?

• Widespread pain (beyond typical territories)
• Body representation/schema disruption
  – “it has a mind of its own”
  – “it feels swollen and tight”
  – “it doesn’t feel like it is mine”... etc.
• Complex sensory dysfunction:
  – Two point discrimination
  – Sensory localization errors
  – Hyper vs. hypoesthesia vs. neglect?

Is it is the representation that we ultimately treat?

What underpins all of these changes?

The elastic, plastic...

fantastic brain

If the root cause of faulty movement is impaired limb representation, motor imagery may allow conscious access to motor preparation areas as a therapeutic intervention

Jeannerod (1995)
Pain in learning for survival value... Is persistent pain destructive learning?

- Brain as the ultimate survivor
- Dynamic brain representations (framework constructed initially by genetics but then sculpted by experience)
  - Brain turf wars
  - Smudging – corruption of sensory, motor and other homunculi
- Neglect-like syndromes observed in persistent pain states
  - Laterality, perceptual changes, “antalgic” patterns, CRPS, etc.

Brain neurosignatures

- The transition from acute to persistent pain relates strongly to:
  - Brain/CNS as the protector
  - Association with harmful (or suspected harmful) activities
  - Learning about the consequences (or suspected consequences) of activities

   Essentially, the brain becomes better at producing pain

Therapeutic aim:

- Un-couple pain neurosignatures (restoring the balance of brain inhibition)
  - Can be done with movement-based therapies, but may be limited due to pain, immobilization, weakness etc.
  - Can also be achieved with GMI (as a precursor or complimentary to movement therapies)

Graded Exposure

- Graded exposure requires identification of both physical and contextual fear-related challenges. It therefore combines the principles of both graded activity and exposure in vivo (Leeuw et al. 2007)
Graded exposure, the pain neurotag and the Twin Peaks model...

disentangling neurotags and the protect by pain line...

Twin Peaks model...

Context variation as part of graded exposure

- Any task can be broken down into parts. A simple way of doing this is to consider a more **physical** aspect, which is perhaps more traditional and a **contextual** component
  - **Physical** – deconstruct the whole task into more manageable bits
  - **Context** = the temporary environment of an action or planned action

Examples of graded exposure in GMI process
**Patience and persistence**

- It is through repeating and gradually ‘exposing’ the brain to the activity in many different ways that allows a reduction in pain and improvement in activity (also critical for functional restoration)
- **Patience & persistence are key** - to appreciate small incremental changes (brain becomes accustomed to the changes without being threatened)

**The cautionary story before the techniques...**

- GMI is a novel management strategy with some clinical and basic sciences behind it. It is a newborn – a toddler perhaps.
- **Do it as best you can, combine it with other appropriate strategies, keep up with the basic sciences and clinical sciences behind it.**
- And remember, you may be dealing with human pain states that have been unchanged for some time. It’s hard work.

**How about some evidence...**

**Explain it to patients...**

- Listen for clues during the patient interview (it’s not mine, disconnected, mind of its own, feels like a block of wood, etc. – disownement statements)
- Watch for clues during the physical exam:
  - Sensory exam: localization (how do you know where I touched you? Show the homunculus, discuss plastic/dynamic maps, provide personal story of changing maps – e.g. new cell phone)
  - Observe for movement impairments (motor control, motor learning, antalgic patterns)
GMI and the NNT

- The Number Needed to Treat (NNT) is the number of patients you need to treat to achieve the desired outcome.
- For pain research, this is often stated as the number of patients needed to treat to achieve a 50% reduction in pain.
- A few NNT's for neuropathic pain:
  - Gabapentin 7.2
  - Strong opioids 4.3
  - Amitriptyline 3.6
  - Graded Motor Imagery 2


Clinical Case Scenario/Vignette

- Weekend Warrior
- (L) wrist fx 2 weeks ago
- Prior (L) shoulder impingement
- Hx of Whiplash 6 yrs. prior
- Mild Fear-Avoidance
- Mild Pain Anxiety due to pain ‘memory’

Biomedical Linear

- Orthopedic physical therapy historically based on structural assessment model (biomechanical)
- Assumes pathology is directly related to pain
- Does not adequately explain all clinical pain states

Biomedical
Bio-psychosocial Emergent

• Pathology is not directly related to pain in many clinical ‘pain’ states

• A bio-psychosocial paradigm includes a neurobiological interpretation that adequately explains many behaviors encountered clinically

This requires ‘reconceptualization’ of known pain mechanisms!

Continuous cycle through time... inputs at conscious and subconscious levels into the neuromatrix (processing) and the subsequent outputs

Mature Organism Model = Bio-psychosocial

Input

• Peripheral
• Traditional & body based
• Biomedical & biomechanical
• Bottom-up
• Manual therapy
• Exercise
• Modalities
• ~ 80% get better
• Keep Doing it!

outputs

Experiences, body's knowledge, culture, motor planning etc.
Output Mechanisms

"Biological coping systems" for the stress' of life. (escape danger, cope and heal)

Designed for short term coping benefits.

Become our Habits & Behaviors

Harmful long term influences.

What comes in, must go out...

- Sensory input from body
- Previous experiences
- Cultural factors
- Social / work environments
- Expectations & consequences of danger
- Beliefs, knowledge & logic

Outputs are what we see and treat

MOVEMENT related

Tissue based.
Active & Passive.
ROM
Strength
Function

What 'systems' do we have to help?

THREAT!

PAIN

MOTOR

IMMUNE

EMOTIONS

COGNITIVE

LANGUAGE

AUTONOMIC

NEURO-ENDOCRINE

outputs
Continuous cycle through time... inputs at conscious and subconscious levels into the neuromatrix (processing) and the subsequent outputs.

Individual response/Output – Neurotag Motivates change

Input into the neuromatrix

Thought, feelings, body, sensory Input

The Neuromatrix Paradigm

Neuromatrix (Melzack) = ALL neural coding space

Neurosignature = representation = event space

(also called 'neurotag')

Body Schema?

Neurotags → (representations!)

Processing = Neuromatrix = Representation

Neurosignatures

• A Map 'of me and my life' in the brain

• The virtual body

Smelling bread

Cervical Stiffness

The Body Neurosignature (body representation / schema)

• There are representations of the body within the
  • Spinal cord
  • Thalamus
  • Cortical structures

• These all play a role in the guidance of imagined and actual movements.

• This is the body neurosignature

Body Maps in the brain!

image/schema/neurosignature

• Sensory
• Motor
• Emotions
• Language
• Cognitions
• Immune
• Endocrine
• Autonomic

These maps are used by the brain to create our perceptions and our world!
The neuromatrix paradigm

- Genetic basis
- Sculpted by life experiences
- Constantly evolving
- Represents Body Organization
- MOVEMENT is necessary

Healthy individuals maintain an organized, and healthy, body schema through movement/exercise and a positive sense of life, etc.

Neurons representing a healthy hand within the CNS

Injury (input) creates automatic changes in body organization/schema... This is a protective 'output' response

Neuroplastic changes of neurons representing the hand after injury (smudging & disinhibition)

Disembodiment metaphors

“my leg doesn’t belong to me”
“it doesn’t feel like the other side”
“I forgot what normal feels like”

“This is a protective ‘output’ response

Treatment interventions have always created adaptive changes in the body and the CNS for pain-free function to return after injury

This should be a paradigm shift in our clinical reasoning

Implicit Motor Imagery

or

Laterality recognition

“my leg doesn’t belong to me”
or
“it doesn’t feel like the other side”
or
“I forgot what normal feels like”

SLIPPING UNDER THE RADAR OF THE PAIN NEUROTAG
The Neuromatrix &
The Body Neurosignature

**Movement**

- Recognizing a body part moving requires an intact ‘body image’ in the brain.

- Modified by observation of others
  - Mirror neuron system
- Modified by tool use
  - Increases influence of the body
- Modified by experience (S1)
  - Musical instruments, Braille

**Input** alone is **NOT** sufficient to change body representation of the affected side

Body representation is influenced by cognitive processes


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**Under the radar of the neurotag?**

Treating the changes in the body image representation may reduce pain.

Treating pain may also normalize the body image representation

Top down & Bottom up!

(Lotze & Moseley 2007)

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**Left/right judgement tasks & body representation**

Laterality recognition = ability to select whether a presented image of a limb is right or left sided.

Cognitive psychologists have used laterality experiments to investigate the body representation (Parsons 2001 Acta Psychologica 107:155-181)

**Reaction time (RT)**

- proportional to the angular position of the limb
- initial selection of right or left
- mental spatial transformation to confirm the choice.

**Accuracy**

Qualitative information – important and often forgotten – may related to emerging disembodiment metaphor and/or other non-verbal behaviors.

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**“Is this a right or left hand?”**

- A response requires initial selection of left or right
- then a mental (sometimes physical) spatial transformation to confirm the choice.
- As such the spatial transformations require an intact body representation.

- Following several images this task becomes less of a conscious effort to perform and is as such described as *implicit*.

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**Is this a left or right hand?**

Rapid initial choice

Mentally manoeuvre body part

Reject or confirmation

(Parsons LM 1987, *Cognitive Psychology*, vol.19, p.178-241)
Implicit motor imagery activates **premotor cortex**

Explicit motor imagery activates **motor cortex**

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**Implicit Motor Imagery?**

- Implicit motor imagery disengages the primary motor cortex (M1), (but still engages the premotor cortex)
- In this way, it is aimed at getting ‘under the radar’ of the neurotag.
- It could be said to ‘dissociate movement and pain’
- Offering a way of being less threatening than imagined movements
- Following several images this task becomes less of a conscious effort to perform, and more **IMPLICIT**.

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**What is the difference between implicit & explicit motor imagery?**

<table>
<thead>
<tr>
<th>Implicit motor imagery (left/right movements)</th>
<th>Explicit motor imagery (imagined movements)</th>
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<tbody>
<tr>
<td>You don’t know you are mentally moving</td>
<td>You know you are mentally moving</td>
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<tr>
<td>Premotor cells modify primary motor cells</td>
<td>Primary motor cells are activated</td>
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<tr>
<td>without activating them</td>
<td>More likely to activate the pain neurotag</td>
</tr>
<tr>
<td>Less likely to activate the pain neurotag</td>
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**Is this person moving to the left or the right?**

- Could it be a way of being less threatening than imagined movement?
**Expectation of pain** influences implicit motor imagery

Expectation of pain influences implicit motor imagery.

Positions expected to be painful are slower in CRPS

Expectation of pain influences implicit motor imagery.

Fig. 1. Average response times to each position for Control, Experimental, Experimental Painful, and Experimental Unpleasant conditions. Positive pain bias, as indicated by increased response time to painful positions, is observed for both Experimental groups compared to Control and Experimental Unpleasant groups. (Hudson et al. 2006 Eur J Pain 10: 219-224)

*Mowsey 2004 Neurology 62: 2182-2186*

**Slower RT on affected side** in acute CRPS

Slower RT on affected side in acute CRPS.

Fig. 2. Mean response times as a function of duration of symptoms and predicted pain associated with adopting the position. Response times are slower on the affected side compared to the non-affected side for patients with acute CRPS. (Mowsey 2004/Schwoebel 2002)

**Duration of symptoms** correlate with response times

Duration of symptoms correlate with response times.

(Mowsey 2004)

**Leg pain also presents with reduced accuracy** in the foot laterality task

Leg pain also presents with reduced accuracy in the foot laterality task.


**Focal hand dystonia** shows changes in implicit motor imagery

Focal hand dystonia shows changes in implicit motor imagery.

Fiorio 2006 Brain 129: 47-54
So somewhere in the progress of the problem, the brain changes “survival tack”....

“I am protecting you... I won’t let you move. I will even limit your premotor preparation—lay off me!”

What are normal values in the hands, neck & backs?

- 2.0 sec RT hands & feet +/- 0.5 sec
- 1.6 sec RT necks & backs +/- 0.5sec
- 88% accuracy hands; 92% accuracy neck & back

- Accuracy and RT should be fairly equal for left & right
- Patient results should remain fairly stable, so they do not fade with stress and remain consistent for at least a week


What is normal Response and Accuracy?

- 1737 participants (1315 pain-free)
- 65% female
- 40 countries worldwide
- Variety of occupations e.g. healthcare practitioners, forestry and farming industry, education, unemployed

Limitations in ACCURACY?

- Infers substantial impairment in the working body schema
  - may be a reflection of imprecision within the neurotags (disinhibition)
  - suggesting a problem integrating the neurotag with preparation of movement

Reaction time

- Increased with age
- Males are a bit faster
- Left handers are bit faster

Accuracy

- Reduced with age
- Unaffected by gender and handedness
- Magnitude of image rotation had an effect

Wallwork et al 2013

Yes, image rotation effects response time!
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Practice effects in normals

- Response times are generally faster on the second attempt of the task
- There is often a small increase in accuracy in control subjects
- Following several images the task requires less attention, hence implicit

Getting started

- Sometimes patients will complain of pain during the initial stages of L/R judgement tasks.
- Possibly because they are using explicit MI initially in order to understand the pictures.
- This should settle when they have repeated several times until it becomes an unconscious (implicit) task.

Recognise online (www.noigroup.com)

Images of left and right body parts are presented randomly in predetermined;
- numbers (eg 5 to 100)
- time (eg 1 second to 20 seconds)
- Context – vanilla to context

Accuracy (%)

95
90
85

Yes, image rotation effects accuracy?

Images of left and right body parts are presented randomly in predetermined;
- numbers (eg 5 to 100)
- time (eg 1 second to 20 seconds)
- Context – vanilla to context

Getting started

- Recognise online
- Flashcards
- Magazines
- Digital camera
- Other methods
- Contextualise

Reaction time and accuracy are scored and graphed.
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Recognise ‘Choices’

Vanilla

Context

Less threatening

Abstract

More threatening
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2/19/2015 – Combined Sections Metting – Anaheim
Quick practice.....
Implicit imagery & Accuracy

- View the 20 images on the screen
- You have 3 seconds to determine R or L
- Check R or L under appropriate column
- Determine your accuracy after all images have played

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<th>Left</th>
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Recognize Apps for;
- hand
- feet
- knees
- shoulders
- necks
- backs

Limitations and uses

Flash cards........Let’s Flash!
Simple

Magazines are Easy!

Creative

GAMES........

Fun....
Non-threatening......
Family & friends......

Best L/R discrimination

slower and less accurate

slowest
Decreased left right discrimination performance has been noted in:

- Spatial neglect (Coslett 1988)
- Amputees (Nico et al 2004)
- Back pain (Bray and Moseley 2011, Bowering 2012)
- Neck pain (Leake 2012)
- Painful knee OA (Stanton et al 2012)
- Carpal tunnel syndrome (Schmid and Coppieters 2012)
- Cervical dystonia (Fiorio et al 2007)
- Focal dystonia (Fiori et al 2006)
- Congenitally absent hand (Funk and Brugger 2008)

Changes in body ‘representation’

So... What about our patient, in a cast, 2 weeks s/p fracture?

- Goal in acute/sub-acute injury.....
- To maintain normal body representation during the healing/repair process.

Left / Right Discrimination?

Anecdotally:
- Post immobilisation
- Post brain surgery
- Regularly in stroke
- Post heart surgery
- Spinal cord injury
- Nerve roots
- Sprains & Strains
- Post-op

Theory and techniques
Explicit Motor Imagery

“A man is not idle because he is involved in thought. There is visible labor and invisible labor.”

Victor Hugo
What is explicit motor imagery?

- Explicit motor imagery (MI) is a cognitive process of imagining a movement of your own body (or part) without actually moving it. (Jeannerod 2003 Behavioural Brain Research 142: 1-15)

- The result of conscious access to the neurosignatures representing:
  - intention
  - preparation
  - carrying out
  - evaluation of a movement

- It depends on a dynamic relationship between the individual, the movement and the environment. (Stevens 2005 Cognition 95:329-350)

Think about it......

Don’t we use imagery all the time?

- Research indicates negative MI plays a large role in many psychological disorders
- Thought virus’?
- Positive MI was found to decrease anxiety and avoidant behaviors in patients with social anxiety.

Notion of cognitive representation

```
Environment

Beliefs

Cause

Timeline

Memories

Consequences

Expectations

Cure/control
```

“There is nothing either bad or good ……
but thinking makes it so.”

(Epictetus / Shakespeare)

“We are what we believe we are.

C.S. Lewis

Watching movement & imagining movement

- Motor imagery in sports is known to improve performance
  (Felz & Landers 1983, Allami et al 2008 Exp Brain Res 184:105-113)
- Use of MI has been shown to improve recovery of motor function in stroke rehabilitation (de Vries & Mulder 2007 J Rehabil Med 39:5-13)
- MI used with musicians improves cortical representation of the motor cortex similar to practice...
- MI is used to develop explicit learning of surgical skills that are cognitively demanding.
- MI is highly effective in treatment of psychological disorders, including anxiety, PTSD, sleep disturbances, depression, etc.
- Demonstrating exercises in the clinic
- Feldenkrais, etc……?
Training explicit motor imagery

Training explicit MI can significantly improve the performance of a task, even when never having performed the task before (Allami et al, 2008)

As an intervention for PLP it alters cortical activation correlating with improved pain intensity and unpleasantness. (MacIver et al, 2008)

But what if thinking about the hand hurts?

- Imagined movements have been found to increase pain and swelling in CRPS 1 patients.
- Thus demonstrating that just activating the representation of the affected body part may be sufficient to ignite the individual pain neurotag.
- It also indicates the importance of progressing each stage only when appropriate.

(Mosley, 2008)

Reflect back

When people use MI properly they experience autonomic responses in anticipation / readiness / preparedness to move

There is a high degree of overlap in brain regions involved in observation, imagination and actual movements

- Imagined movements activate the same motor regions... As actual movements......
  - but to a much smaller degree (Ehrsson, et al 2003)

- Explicit motor imagery is a way of grading the exposure to movement
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Explicit motor imagery grading exposure to executed movements


Watching someone move will activate motor regions, but to a lesser extent than imagined, or actual, movements. (Nedelko, et al, 2010)

likely due to the mirror neurons

Mental Imagery creates a broader neurosignature as compared to observation

Taking a step back to watching as therapy

Action Observation as therapy

Explicit Motor Imagery...Getting started

- This is a kinesthetic activation... Not visual!
- The patient must IMAGINE & FEEL themselves doing the movement.
- Not as an observer watching themselves doing the movement (Dickstein & Deutsch 2007/Enzinger 2006)
- It is a FIRST person task
- Visual/THIRD person imagery may be a good way of stepping back!

Patient and Clinician Reflections

- Where do I do it?
- Eyes open or closed?
- What position do I adopt?
- Me moving or someone else?
- How long will I do it?
- Task complexity and intensity?
- What words should I use?
- Prior demonstration?
- Cues to heighten the process?
- Relaxation or meditation in conjunction?
- How much do I know about the brain and what I am trying to deal with?
Explicit Imagery

- It may be that you need to vary different elements of the task to make it more individualized, understandable or threatening...including: (environment, language, etc)
  - Eyes open or closed (Heremans 2009 Brain Research 1278:50-58)
  - Starting position
  - Environment
  - Sensory cues
  - Words used to describe the process
  - Memories
  - Emotions
  - Length of time/time of day

Imagine

- Imagine what it might feel like to have a body part in a certain position
- Imagine what it might feel like to have a body part doing a certain movement
- Imagine what it would be like to manipulate an object
- Imagine what it is like to move like a certain person
- Just ‘watching’ may be ‘easier’ on the brain than thinking about movement

So.... What about our patient, in a cast, 2 weeks s/p fracture?

- Goal in acute/sub-acute injury.....
- To maintain normal body representation during the healing/repair process
- Progress from static MI positions to dynamic movement and functional activities...
- Recognize on line?
- Recognize Apps?
- Flash cards?
- Magazines?
- Observing others?

The PETTLEP model is the most widely used and well documented method of preparing a MI intervention

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All imagery tasks should consider and include;
- Movement goal
- Threat considerations
- Less threatening to start
- Specific to the individual
- A Neurobiology explanation
- Robust environmental sensations
- Short time frames (5-10 min.)
- Frequent practice daily

Imagery Options

- Recognize Online
- Picture books
- Movies/ You tube
- Mall / Airport, etc.
- Work / Home
- Audio recordings
- Smart phone specific for each individual/client

So.... What about our patient, in a cast, 2 weeks s/p fracture?

- Imagine what it might feel like to have a body part in a certain position
- Imagine what it might feel like to have a body part doing a certain movement
- Imagine what it would be like to manipulate an object
- Imagine what it is like to move like a certain person
- Just ‘watching’ may be ‘easier’ on the brain than thinking about movement
Mirror Therapy
therapist as illusionist!

• Mirrors have been used in many forms over the years.

Use of mirrors in patient care following CVA

Clinicians often use mirrors to show postural and movement related feedback

Mirror therapy is ‘an experience to be explored’
Not a Rx applied to a clinical condition

• Changes in body schema create altered sensory & movement sensitivity.

• A ‘mirror reflection’ of the intact limb tricks the brain into ‘seeing’ the sensitive body part more normally.

• Mirror exercises create a less threatening neurosignature of the body part and alter the body schema.

Mirror therapy in acute stroke shows improvements in motor, sensory & attentional measures
(Dohle et al 2009 Neurorehab Neural Repair 23(3): 209-217)

Mirror therapy?
Using the mirror to trick the brain into thinking that the limb moving is in fact the hidden limb.

Easiest to set up for hands and feet

Requires more careful positioning and larger mirrors for legs, hips, trunk, shoulders, neck.
When viewing a body part in a mirror there is activation of M1...

M1 is activated in both brain areas corresponding to the moving limb & hidden limb...

This activation is slightly greater than when imagining the movement of the hidden limb...

But less activation than actual execution of the movement...

What about the patient who presents with Dysynchiria?

Dysynchiria is not a feature of other neuropathic pain states.

Mirrors & cortical reorganization

In patients with PLP, activation of the hidden limb appears to be lost or "less"...

This can be re-trained...

Effective functional training using mirrors shows changes in cortical activity of motor areas

Viewing your own body creates an analgesic effect in nociception

It appears that viewing the reflection of a limb has analgesic properties similar to looking at the limb when it is not hidden

Practitioner Perspective

Engage active participation

Optimistic & confident, (+)

Relaxation instructions;
– Encouragement about seeing, feeling, thinking, EXPLORING

Introduction to mirror

Minimal intervention after this point

Patient’s Perspective

Expectations

Active Participation
– Life changing
– Understand correct procedure for best results

FOCUS – very important
– If focus is not there, return to expectation, management/instruction

Correct mind-set for ‘exploration’ is crucial
Reaction

- Often verbal reactions
  - Surprise
  - Semi-‘Shock’
- Emotional Reunion
  - DO NOT interrupt
  - No matter how long
  - Full emotional relief
- Fascination & Exploration
- Fatigue

Practicalities when progressing to a mirror

- Mirror Box of high quality
- Guided by a skilled clinician who knows the brain
- Prepare the patient?
- Sit “evenly”
- No jewelry or tattoos—“total illusion”
- Graded exposure principles
  - Pain & associated sx’s?
- Determine appropriate activity
  - Looking, movement, touching, weight bearing

Some suggested Mirror Progressions

- Look at hand
- Turn hand up and down via elbow
- Flatten out the hand
- Flatten hand and then take weight through it
- Move individual fingers
- Finger thumb opposing
- Tapping fingers
- Add increasing muscle activity to each movement

Context variables to alter

- Place (from safe to feared places)
- Emotion
- Time of day
- Try movements while distracted (whistling a tune)
- Music
- Sitting, standing, lying down
- Smells
- Noises
- Background
- Textures (carpet, cloth)
- Water

Other Practicalities & Progression

- “conquer the movement” before progressing
  - Modify the context; music, emotions, smells. Etc.
  - “knock on the door first” but “don’t come in until you are welcomed”
  - Painful limb positioning/non painful limb positioning?
  - Odd asynchronous movements

Mirror Progressions

Use tools, shoes, etc..

- Screw driver, nail cutters, pen, scissors, knife, etc.
- Running shoes, work boots, high heels

Introduce clinician’s hand onto affected body part

Massage and caressing by a loved one’s hand

Interventions should progress in context/environment from “Less threatening to More threatening”
Mirror progression – graded exposure & contextual change

<table>
<thead>
<tr>
<th>Threat value</th>
<th>Inside box</th>
<th>Outside box</th>
</tr>
</thead>
<tbody>
<tr>
<td>Less threatening</td>
<td>Keep hand still/comfortable</td>
<td>Keep hand still – just observe reflection</td>
</tr>
<tr>
<td>Oppose fingers</td>
<td>Oppose fingers &amp; press with force</td>
<td>Move fully – include a tool</td>
</tr>
<tr>
<td>Oppose fingers</td>
<td>Oppose fingers &amp; press with force</td>
<td>Move fully – include a tool</td>
</tr>
<tr>
<td>More threatening</td>
<td>Oppose fingers</td>
<td>Move fully – include a tool</td>
</tr>
<tr>
<td>Most threatening</td>
<td>Include tools that have threat attached to them</td>
<td>Copy hand in box</td>
</tr>
</tbody>
</table>

**Baseline level of activity**

- 1 min mirror exercises each session
- 1½ mins of mirror exercises each session
- 2 mins of mirror exercises each session
- 2½ mins of mirror exercises each session

**Time**

'Virtual Reality' exercises need frequent practice...
You are exercising to improve synaptic endurance and strength
No data on how much, how many, how long.....
I recommend 2 X 15' sessions/day for 4-5 weeks for my patients

**The clinical reality**

Integrating Graded Motor Imagery into practice

• Training has to be intense & behaviourally relevant for cortical reorganisation

**Preparing your patient**

**Neuroscience/psychology blended style**

Neuroscience style

(+ ) impact when using neuroscience links to the health of body and tissues

Decreased THREAT........

Property of Stephen Schmidt & Robert Johnson – Not for distribution without permission
Neuroscience style education is effective

- Decrease Threat
- Endocrine
- Immune
- Autonomic
- Language
- Mood
- Respiration
- Pain
- Motor

Reconceptualisation is required

- Takes structural pathological issues - BIOMEDICAL
- Places them on a framework of neuroscience - BIOPSYCHOSOCIAL

- Patients able to be trained in pain neurobiology
- Health professionals underestimate ability of patients to understand information


Reconceptualisation is Necessary

- May challenge long held beliefs
- Underlying brain changes does not mean brain damage
- This is reversible but will take patience and persistence
- Requires good understanding of the concept & endorsement of the treatment by the clinician
- Knowledge is context – considered an ‘output liberator’ it changes patient’s thoughts and beliefs
- Take ‘Explain Pain’ before GMI !!!!

Who would I consider using GMI for?

Every ‘body’........

Know Pain or no Gain

- EP/TNE evidence suggests a variety of education tools you might need....
  - Data or facts
  - Reading materials
  - Pictures
  - Stories
  - Metaphors
  - Video or photo’s
  - Internet
  - Magic dust

PRESENT
CONCEPTUAL
CHANGE MESSAGE

?
GMI summary

- Laterality Reconstruction
  - Number of images
  - Speed of images
  - Rotation of images
  - Accuracy
  - Threat value of images

- Mirror Feedback
  - Complexity of mirror action
  - Duration
  - Environmental input (noise, aroma, etc.)
  - Contextual "visual field" input (tools, objects, etc.)

- Motor Imagery
  - Duration
  - Complexity of mental image
  - "Feeling" the movement (kinaesthetic awareness)

- Active Movement
  - ROM
  - Repetitions
  - Resistance
  - Distractions

Graded Exposure Summary:

- Physical movement rehabilitation
- Mirrored positions & movements
- Imagined positions & movements
- Laterality reconstruction

Movement & Education
Mirror Mirror in My Brain: Graded Motor Imagery to Improve Clinical Outcomes

Thank you!

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