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Mirror Therapy

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I. Introduction:

The principle of mirror therapy (MT) is the use of a mirror to create a reflective illusion of an affected limb in order to trick the brain into thinking movement has occurred without pain. It involves placing the affected limb behind a mirror, which is sited so the reflection of the opposing limb appears in place of the hidden limb. A Mirror box is a device which allows the clinician to easily create this illusion. It' is a box with one mirror in the centre where on each side of it, the hands are placed in a manner that the affected limb is kept covered always and the unaffected limb is kept on the other side whose reflection can be seen on the mirror.

II. Background

Mirror therapy was invented by Vilayanur S. Ramachandran to help alleviate the Phantom limb pain, in which patients feel they still have a pain in the limb even after having it amputated.

Ramachandran and Rogers-Ramachandran first devised the technique in an attempt to help those with phantom limb pain resolve what they termed a **'Learned Paralysis**' of the painful phantom limb. The visual feedback, from viewing the reflection of the intact limb in place of the phantom limb, made it possible for the patient to perceive movement in the phantom limb. Their hypothesis was that every time the patient attempted to move the paralyzed limb, they received sensory feedback (through vision and Proprioception) that the limb did not move. This feedback stamped itself into the brain circuitry through a process of Hebbian learning, so that, even when the limb was no longer present, the brain had learned that the limb (and subsequent phantom) was paralyzed. To retrain the brain, and thereby eliminate the learned paralysis, Ramachandran and Rogers-Ramachandran created the mirror box.

III. Techniques of Mirror Therapy

The patient places the good limb into one side, and the stump into the other. The patient then looks into the mirror on the side with good limb and makes "mirror symmetric" movements, as a symphony conductor might, or as we do when we clap our hands. Because the subject is seeing the reflected image of the good hand moving, it appears as if the phantom limb is also moving. Through the use of this artificial visual feedback it becomes possible for the patient to "move" the phantom limb, and to unclench it from potentially painful positions.

IV. Principles of Mirror Therapy

1. This approach exploits the brain's preference to prioritise visual feedback over somatosensory/proprioceptive feedback concerning limb position. In conditions such as phantom limb pain (PLP), stroke, or Chronic Regional Pain Syndrome Type 1 (CRPS1) where neuropathic processes cause issues with pain, related or unrelated to movement, this approach is thought to offer potential relief.

2. MT has been shown to increase cortical and spinal motor excitability, possibly through the effect on the **Mirror Neuron System**. Mirror Neurons accounts for about 20% of all the neurons present in a human brain. These mirror neurons are responsible for laterality reconstruction i.e., ability to differentiate between the left and the right side. When using the Mirror box, these mirror neurons gets activated and helps in the recovery of affected parts. This system is thought to use the observation of movement to stimulate the motor processes which would be involved in that movement. Similarities have been drawn with motor imagery where by the individual will mentally imagine movements rather than observing the reflection of a movement in a mirror. It is thought that the brains natural inclination to prioritise visual feedback over all others would make MT a more powerful tool, however research evidence is currently lacking in support of this hypothesis. It is to be noted that the major difference in the neuronal reorganisation while using a mirror box is that the ipsilateral hemisphere's neurons gives connection to the same side affected limbs rather than the conventional therapies which targets the neuronal reorganization of the contra-lateral hemisphere.

Mirror

The dimension of the mirror should be big enough to cover the entire affected limb and should allow patients to see all major movements in the mirror. A size of 25 X 20 inches for the upper limb should be large enough for everyday usage.

There are mirrors available made of different materials (glass, foil, acrylic glass). When choosing a mirror one should pay attention to the following aspects:

- ★ It should provide a coherent mirror image without any noteworthy distortion.
- ★ There should be no risk of injury, ex., through the edges of the mirror.

Exercise Materials

Besides objects that are needed for functional motor training (ex, Cups, Towels) materials with more sensory input can be used, especially in patients with impairments in body perception.

- ★ Plastic bowl or tubs filled with sand or peas.
- ★ Hedgehog ball
- ★ Temperature stimuli (Warm, Cold)
- ★ Different Brushes
- ★ Washing up Gloves
- ★ Sand Paper.

V. Treatment Characteristics:

Frequency of Therapy & Duration of Sessions

The available literature recommends performing mirror therapy at least once daily with minimum duration of ten minutes. The maximum duration of each session is dependent on the cognitive abilities of the individual patient and/or negative side effects, but in most cases will around 30 minutes. It is also possible to split one session into two shorter sessions of 10 to 15 minutes with a short break in between, if patient's abilities do not allow longer sessions. A daily treatment session using mirror therapy will be beyond the possibilities in many clinical settings. In such cases, patients will require instruction about unsupervised training using the mirror as early as possible, to enhance treatment intensity.

Position of Affected Limb

The affected limb should be positioned on a height adjustable table so that its position can be adjusted to the length of the patient's trunk and arm. The affected limb is situated in a safe and preferably comfortable position behind the mirror. In case of severe muscle spasticity, preliminary manual mobilization may be necessary and helpful before positioning the limb.

Position of Non-Affected Limb

The patient should try to facilitate a vivid "mirror illusion" (Mirror image perceived as the affected limb) by matching the position and image of the non-affected limb to the affected side. For ex, the non-affected limb should be positioned in a similar position as the affected limb, as this facilitates the intensity of the mirror illusion.

Position of the Mirror

Generally the mirror is positioned in front of the patient's midline, so that the affected limb is fully covered by the mirror and the reflection of the unaffected limb is completely visible. In the case of visuospatial neglect o severe muscle spasticity in the affected limb, the position of the mirror can be adjusted in such a way that it points more diagonally towards the unaffected limb. The important point when adjusting the position of the mirror is to assure that the mirror image still matches with the perception of the affected limb.

Evidence on Effectiveness

Most of the evidence since the early work has come from case studies and anecdotal data. Chan et al (2007) allocated 22 patients with Phantom Limb Pain (PLP) into a mirror therapy group, mental imagery group and a covered mirror group (control). They reported that all patients in the mirror therapy group experienced reduced PLP. This was not the case in the other two groups. The study did not control potential biases and its methodology was not described in detail, so weakening the power of its findings.

A more robust trial investigated two groups of subjects suffering with PLP. A mirror group were compared to a covered mirror group; however, there were no statistically significant reductions in PLP between groups.

In 2011 a large scale review of the literature on mirror therapy by Rothgangel summarized the current research as follows:" For stroke there is a moderate quality of evidence that MT as an additional intervention

improves recovery of arm function, and a low quality of evidence regarding lower limb function and pain after stroke. The quality of evidence in patients with complex regional pain syndrome and phantom limb pain is also low. Firm conclusions could not be drawn. Little is known about which patients are likely to benefit most from MT, and how MT should preferably be applied. Future studies with clear descriptions of intervention protocols should focus on standardised outcome measures and systematically register adverse effects".

A further review of current approaches in the treatment of PLP concluded that the benefits of mirror therapy appear to be limited to patients who suffer from cramping and muscular-type phantom pain. They noted that despite the findings of one RCT, there was no systematic evidence to support the use of this modality and even some suggestion it could be counterproductive. However, this may be due to study design, choice and size of sample and application of the modality.

Diers et al (2010) noted that applying MT as part of a sequence of modalities appeared to produce positive results against applying it in isolation. In an RCT, patients with CRPS1 and PLP showed decreases in pain, and improved function both immediately post treatment and at a 6 month follow-up when using mirror training as part of a sequence of modalities known as Graded Motor Imagery (GMI). Mirrored imagery alone did not, however, activate cortical processes in patients with phantom limb pain. The authors concluded that further research was required to establish the cortical processes underlying MT and motor imagery in order to guide the optimal method of application for these modalities.

These findings appeared to support earlier suggestions that whilst mirrored movements may expose the cortex to sensory and motor input, the therapeutic effect is magnified if cortical networks were gradually activated using limb recognition, motor imagery and finally mirrored movement. This sequence of modalities became known as GMI. Using a single blind randomised control design this approach was investigated with patients suffering with PLP, CRPS and brachial plexus avulsion. Whilst the heterogeneity of the sample was acknowledged, it was argued that cortical similarities exist between these conditions causing a cortical neglect of the affected limb leading to changes in cortical mapping. The sample size in each study was small, but both studies showed significant reductions in pain and cortical reorganisation following a six week program.

VI. Graded Motor Imagery

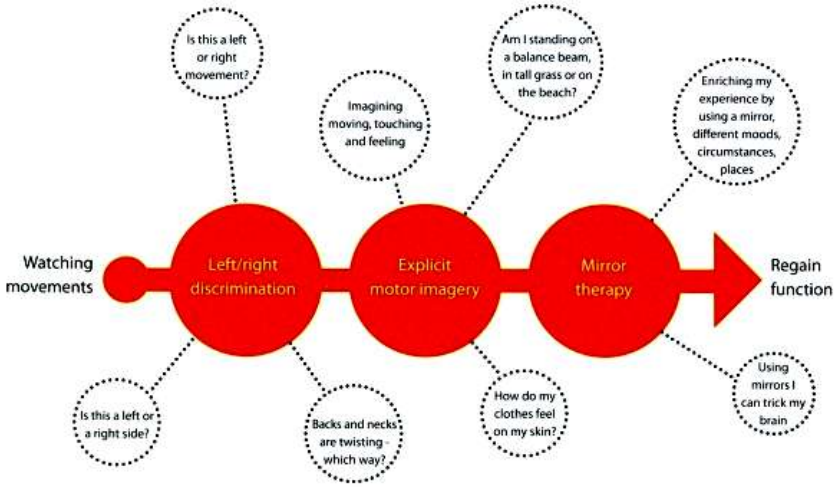
Graded Motor Imagery (GMI) is a rehabilitation process used to treat pain and movement problems related to altered nervous systems by exercising the brain in measured and monitored steps that gradually expose the cortex to sensory and motor input and so enable cortical networks to open up in response.

GMI has become accepted as a method of treating neuropathic pain and associated movement disorders. By exercising the brains in measured and monitored steps the approaches seeks to gradually exposure the cortex to sensory and motor input and so enable cortical networks to open up in response.

GMI involves 3 steps as follows:

1. Left/right discrimination training
2. Motor imagery exercises
3. Mirror therapy

These techniques are delivered sequentially but require a flexible approach from the patient and clinician to move forwards, backwards and sideways in the treatment process to suit the individual.



Mirror Therapy in Stroke

Mirror therapy (MT) has been employed with some success in treating stroke patients. Clinical studies that have combined mirror therapy with conventional rehabilitation have achieved the most positive outcomes. However there is no clear consensus as to its effectiveness. In a recent survey of the published research Rothgangel concluded that "In stroke patients, we found a moderate quality of evidence that MT as an additional therapy improves recovery of arm function after stroke. The quality of evidence regarding the effects of MT on the recovery of lower limb functions is still low, with only one study reporting effects. In patients with CRPS and PLP, the quality of evidence is also low." A recent Cochrane Review summarised the effectiveness of mirror therapy for improving motor function, activities of daily living, pain and visuospatial neglect in patients after stroke. 14 studies with a total of 567 participants that compared mirror therapy with other interventions were compared. At the end of treatment, mirror therapy improved movement of the affected limb and the ability to carry out daily activities, it reduced pain after stroke, but only in patients with a complex regional pain syndrome and the beneficial effects on movement were maintained for six months, but not in all study groups.

VII. Summary

MT is a non-pharmacological and alternative treatment strategy that has been proposed as a means of managing PLP. It is a neuro-rehabilitation technique designed to remodulate cortical mechanisms. With this technique, patients perform movements using the unaffected limb whilst watching its mirror reflection superimposed over the (unseen) affected limb. This creates a visual illusion and provides positive feedback to the motor cortex that movement of the affected limb has occurred. The approach is thought to offer potential relief through the visual dominance upon motor and sensory processes.

Considering the importance of PLP and its management, MT offers clinicians an easy-to-use and low-cost adjuvant therapeutic technique. However, its effectiveness as a standalone modality largely arises from low quality evidence. Instead, there is a greater weight of evidence in favour of its use as a combined or sequential therapy, such as Graded Motor Imagery.

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