(June 15, 2017)

Mirror-Visual Feedback Recent Reviews: A list of placebo-controlled clinical trials and case reports

(A lay summary of our work from the BBC World Review for non-specialists, patients, and physicians is included at the end.)

Controlled Clinical Trials using Mirror Visual Feedback (MVF) have now established the efficacy of the procedure for many neurological conditions. There are over 100 published studies.

Evidence for the Utility of MVF in Neurology

Recent work is highlighted in red

Mirror Visual Feedback (MVF) for Stroke

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Mirror Visual Feedback for Conditions other than Stroke:

Phantom Limbs

The use of visual feedback to treat neurological dysfunction and pain was first introduced by Dr. Ramachandran UCSD.

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RSD (CRPS)

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Hand Therapy

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Neglect syndrome

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Alien Hand Syndrome

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Corpus Callosum Disconnection

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Mirror Visual Feedback for Neuro-typicals

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Back Pain

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visualization of the back during movement. Clin J Pain. 2012;28(7):602–608. doi: 10.1097/AJP.0b013e31823d480c.

Trigeminal Neuralgia

1. Annegret Hagenberg Clear Effect of Mirror Therapy on Trigeminal Neuralgia Pain(2014). Journal of Observational Pain Medicine – Volume 1, Number 3. ISSN 2047-0800

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Parkinson's

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Other Related Articles

1. Pandian S, Arya KN. Motor impairment of the ipsilesional body side in poststroke subjects. J Bodyw Mov Ther 2013;17:495-503.

2. Pandian S, Arya KN, Kumar D. Effect of motor training involving the less-affected side (MTLA) in post-stroke subjects: A pilot randomized controlled trial. Top Stroke Rehabil 2015;22:357-67.

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Abstracts of Recent Review Articles on Mirror Visual Feedback for Stroke

1. UNDERLYING NEURAL MECHANISMS OF MIRROR THERAPY: IMPLICATIONS FOR MOTOR REHABILITATION IN STROKE

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Abstract
Mirror therapy (MT) is a valuable method for enhancing motor recovery in poststroke hemiparesis. The technique utilizes the mirror-illusion created by the movement of sound limb that is perceived as the paretic limb. MT is a simple and economical technique than can stimulate the brain noninvasively. The intervention unquestionably has neural foundation. But the underlying neural mechanisms inducing motor recovery are still unclear. In this review, the neural-modulation due to MT has been explored. Multiple areas of the brain such as the occipital lobe, dorsal frontal area and corpus callosum are involved during the simple MT regime. Bilateral premotor cortex, primary motor cortex, primary somatosensory cortex, and cerebellum also get reorganized to enhance the function of the damaged brain. The motor areas of the lesioned hemisphere receive visuo-motor processing information through the parieto-occipital lobe. The damaged motor cortex responds variably to the MT and may augment true motor recovery. Mirror neurons may also play a possible role in the cortico-stimulatory mechanisms occurring due to the MT.

Citation
Arya KN. Underlying neural mechanisms of mirror therapy: Implications for motor rehabilitation in stroke. Neurol India 2016;64:38-44

2. MIRROR THERAPY COMBINED WITH BIOFEEDBACK FUNCTIONAL ELECTRICAL STIMULATION FOR MOTOR RECOVERY OF UPPER EXTREMITIES AFTER STROKE: A PILOT RANDOMIZED CONTROLLED TRIAL

Jung Hee Kim Byoung, Hee Lee

Abstract
The objective of this study was to evaluate the effects of mirror therapy in combination with biofeedback functional electrical stimulation (BF-FES) on motor recovery of the upper extremities after stroke. Twenty-nine patients who suffered a stroke > 6 months prior participated in this study and were randomly allocated to three groups. The BF-FES + mirror therapy and FES + mirror therapy groups practiced training for 5 × 30min sessions over a 4-week period. The control group received a conventional physical therapy program. The following clinical tools were used to assess motor recovery of the upper extremities: electrical muscle tester, electrogoniometer, dual-inclinometer, electrodynamometer, the Box and Block Test (BBT) and Jabsen Taylor Hand Function Test (JHFT), the Functional Independence Measure, the Modified Ashworth Scale, and the Stroke Specific Quality of Life

(SSQOL) assessment. The BF-FES + mirror therapy group showed significant improvement in wrist extension as revealed by the Manual Muscle Test and Range of Motion ($p < 0.05$). The BF-FES + mirror therapy group showed significant improvement in the BBT, JTHT, and SSQOL compared with the FES + mirror therapy group and control group ($p < 0.05$). We found that BF-FES + mirror therapy induced motor recovery and improved quality of life. These results suggest that mirror therapy, in combination with BF-FES, is feasible and effective for motor recovery of the upper extremities after stroke.

Citation
Kim, J. H., & Lee, B. (2014). Mirror Therapy Combined With Biofeedback Functional Electrical Stimulation for Motor Recovery of Upper Extremities After Stroke: A Pilot Randomized Controlled Trial. *Occupational Therapy International,22*(2), 51-60. doi:10.1002/oti.1384

MVF for Other Disorders

1. EFFECT OF MIRROR VISUAL FEEDBACK ON HAND FUNCTIONS IN CHILDREN WITH HEMIPARESIS

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Background
Hemiparetic and hemiplegic cerebral palsy(CP) constitute at least a third of all people with CP. Children with hemiparesis are suffering from weak hand muscles and retarded hand use.Mirror therapy is a relatively new approach in rehabilitation used in different neurological disorders. In mirror therapy a mirror is positioned orthogonally in front of the center of the patient's body. The less-affected (healthy) extremity is moved and observed in the mirror. The purpose of this study was to determine the effect of mirror visual feedback on improving hand functions in children with hemiparesis.
Methods: Forty children with hemiparesis of both sexes, ranged in age from five to seven years old, participated in this study. They were divided randomly into two groups of equal number (control and study). The control group received a specially designed physical therapy exercise program for four successive weeks while the study group received mirror exercise program in addition to the same program of the control group. Hand functions assessments was done using grasping and object manipulation subtests of Peabody developmental motor scale (PDMS-2). Evaluation was performed pre and post treatment program.

Results
There was no significant difference between both groups in the pre-treatment mean values of all measured variables. Also, the results of this study revealed a significant

improvement in the scores of the PDMS-2 andin grasp strength of the 2 groups. Post treatment results revealed more improvement in favor of the study group as compared with the control group.

Conclusion
Using the mirror visual feedback could help in improving hand functions in children with hemiparesis.

Citation
Elsepaee, M. I. (2016). Effect of Mirror Visual Feedback on Hand Functions in Children with Hemiparesis. *International Journal of Physiotherapy,3*(2). doi:10.15621/ijphy/2016/v3i2/94869

2. MIRROR THERAPY FOR COMPLEX REGIONAL PAIN SYNDROME (CRPS)--A LITERATURE REVIEW AND AN ILLUSTRATIVE CASE REPORT

Samaa Al Sayegh, Tove Filén, Mats Johansson, Susanne Sandström, Gisela Stiewe, Stephen Butler

Highlights
•A patient with long-standing CRPS of the lower extremity, improved with mirror therapy.
•Review of CRPS signs and symptoms and the now accepted diagnostic criteria.
•Review of mirror therapy for pain and rehabilitation of CRPS, phantom limb, and stroke.
•Review and evaluation of the published literature for mirror document effects in good quality studies.

Abstract
Background and purpose
This case of a 42 year old woman with lower extremity Complex Regional Pain Syndrome (CRPS) after a twisting injury of the ankle, effectively treated with the addition of mirror therapy to a rehabilitation programme, prompted a literature review of both CRPS and mirror therapy. Mirror therapy is a newer adjunct to other forms of pain control and functional restoration for treatment of CRPS as well as other difficult clinical problems. This was a required group project as part of a university based course in chronic pain for healthcare workers.

Materials and methods
The PubMed database up to September 26, 2012 was reviewed using four search word groups: “CRPS mirror therapy”, “mirror CRPS”, “reflex sympathetic dystrophy OR Complex Regional Pain Syndrome AND mirror” and “reflex sympathetic dystrophy OR Complex Regional Pain Syndrome AND mirror + RCT”. Nine studies from PubMed met the criteria that this working group had chosen for inclusion in the analysis of mirror therapy as treatment. These references were supplemented

by others on CRPS in order to generate an adequate review of both the syndrome CRPS and mirror therapy itself. Some references were specific for mirror therapy in the treatment of CRPS but others described mirror therapy for the treatment of phantom limb pain, brachial plexus avulsion pain, for physical rehabilitation of stroke related paresis and for rehabilitation after hand surgery.

Results

Criteria for the diagnosis of CRPS including the International Association for the Study of Pain criteria and the Budapest criteria are reviewed with an emphasis on the specificity and sensitivity of the various criteria for clinical and research purposes. The signs and symptoms of CRPS are a part of the criteria review.

The main treatment strategy for CRPS is physical rehabilitation for return of function and mirror therapy is one of many possible strategies to aid in this goal.

The patient in this case report had failed many of the adjunctive therapies and rehabilitation had been unsuccessful until the addition of mirror therapy. She then could progress with physical rehabilitation and return to a more normal life. Mirror therapy techniques are briefly described as part of a discussion of its success with relationship to signs and symptoms as well as to the duration of CRPS (and other syndromes). Some discussion of the theories of the central effects of both CRPS and phantom limb pain and how these are affected by mirror therapy is included.

An analysis of the 9 most relevant articles plus a critique of each is present in table form for review.

Conclusions

There appears to be a clear indication for the use of mirror therapy to be included in the multidisciplinary treatment of CRPS types 1 and 2 with a positive effect on both pain and motor function. There is also evidence that mirror therapy can be helpful in other painful conditions such as post stroke pain and phantom limb pain.

Implications

CRPS is often overlooked as an explanation for obscure pain problems. Prompt diagnosis is essential for effective treatment. Mirror therapy is a newer technique, easy to perform and can be a useful adjunct to aid physical rehabilitation and decrease pain in this population. Much further prospective research on mirror therapy in CRPS is ongoing and is needed to systematize the technique, to clarify the effects and to define the place of this therapy in the multidisciplinary management of CRPS.

Citation

Manen, V. S. (2012). Treatment of Complex Regional Pain Syndrome (CPRS) Type I with Mirror Therapy. *Http://isrctn.org/*>. doi:10.1186/isrctn97144266

See following pages for a summary of our clinical work for non-specialists.

What phantom limbs and mirrors teach us about the brain **by Stephanie Hegarty BBC World Service: From the section Magazine comments (5 December 2011).**

In a lab in southern California, scientists are curing the previously incurable with little more than a mirror, and changing our understanding of the brain in the process.

Ramachandran's 20-year association with the mirror, and phantom limbs, has driven him to the forefront of experimental neuroscience.

How the mirror works

The phantom (or arthritic) hand is placed behind the mirror. When the patient looks into the mirror he feels the reflection of the real hand superimposed on the phantom. He then tries to move both hands.
Many patients report they feel the phantom mimicking the movement of the real hand.

When the real hand opens its fingers, it looks as though the phantom has opened, and pain is relieved. By doing this repeatedly some patients find the phantom disappears. Providing a visual substitute for the phantom limb effectively "amputates" it.

The syndrome occurs in at least 90% of amputees - in two-thirds of those it manifests as an insatiable itch in the missing limb, many feel extreme discomfort or even chronic pain.

In most cases, pain-killers and surgical treatment have no effect.
Ramachandran's first phantom limb patient - who he calls Victor - lost his arm crossing the Mexican border into the US. He had an itch in his missing hand.
When Ramachandran prodded him in the left cheek with a cotton bud, Victor claimed he felt it in his missing left thumb - when he touched his upper lip, Victor though he was prodding his index finger.
The neurons that detect sensation in the missing hand, at a loss for anything to do, had somehow started detecting sensation in the face.

In this case there was a simple and effective treatment for the itch - scratch the face. But to Ramachandran it also had theoretical implications. It appeared to demonstrate the plasticity of brain modules - their ability to adapt to each other and their environment. This was a radical idea as the established notion at the time was that the brain is made up of independent modules, insulated from each other and hardwired to a specific function. The notion of plasticity was something only a small group of scientists were considering.

The "Mirror-Neuron"

In 1994, Ramachandran proved the theory by mapping the brain activity of a group of amputees. Using a magnetic scanner he showed that neuron activity was indeed migrating from the hand area to the face. It was a ground-breaking study.
But he believed much more could be gleaned from studying phantom limbs.

Since 1999 Ramachandran has been exploring the connections between brain modules through a condition called synaesthesia.
Synaesthetes experience a blending of their sensations - they taste letters, hear shapes or see numbers as colours. It affects 2-4% of people, is hereditary and eight times more common among artists and creative people.

Ramachandran suggests that synaesthetes have a higher number of connections between modules in the brain that process sensations such as colour and sound. He believes the condition holds clues to unravelling the mysteries of human capacity for language, creativity and abstract thought.

Do you have synaesthesia? Try and pick out the twos in this sea of fives. Number-colour synaesthetes will see the twos pop out while normal people have to look at each figure individually to tell them apart.

In the mid-1990s he followed the work of Italian scientist Giacomo Rizzolatti, who discovered an entirely new type of neuron that he called the mirror neuron.

Rizzolatti observed that certain neurons in the brain of a macaque monkey fired when the monkey reached out and when it watched another monkey reach out. Mirror neurons were later discovered in humans too.
Ramachandran began to apply this finding to his work with phantom limbs. If mirror neurons fired when an individual watched someone moving a limb, he conjectured, then visual perception might play an important role in creating the sensation of movement.

His next subject, Jimmy, felt that his phantom hand was always agonisingly clenched, with his phantom fingernails digging into his missing hand.
Ramachandran put a mirror between Jimmy's arms and asked him to move both his phantom and healthy limb simultaneously, while looking at the reflection of the healthy limb - effectively fooling Jimmy's brain into thinking his phantom was moving in a normal way.

Jimmy felt his clenched fist release almost immediately.
"This is because you are creating intense sensory conflict - the vision is telling you the limb is moving," Ramachandran explains.
"One way the brain deals with conflict is to say, 'To hell with it! There is no arm,' and the arm disappears.
"I tell my medical colleagues that it is the first example in the history of medicine of successful amputation of a phantom limb."
He called the treatment Mirror Visual Feedback therapy or MVF. But it wasn't until much later that MVF was properly acknowledged by clinicians.

Empathy

In 2007, an army medic in the US Dr Jack Tsao, performed a controlled test on 22 amputees with remarkable results. All those using the mirror reported a reduction in pain over four weeks, those using a control reported no result or increased pain.
At the UK army's rehabilitation centre, Hedley Court, mirror therapy has also been used for the past four years to help amputee soldiers to manage phantom pain.

Mirror Neurons and Landmines

Thiet Nguyen Xuan from Vietnam was hunting for scrap metal on a beach in September when a landmine exploded, blowing off both of his legs and two fingers from his left hand.

Since the accident, he has felt a burning sensation in his missing fingers. The End the Pain project has provided him with a mirror and training on how to use it. During the training he reported instant relief in his phantom fingers. Over the next two months the project will monitor his progress.
End the Pain hopes to extend mirror therapy to the estimated 300,000 amputees in Vietnam.

End the Pain Project

"Prosthesis-wearing is key," says army physiotherapist Major Pete LeFeuvre. Those who wait longer for a fake limb seem to suffer more from phantom pain. This suggests it is the visual feedback of seeing an arm rather than the feedback from nerves within it that stops the brain getting confused.

In Vietnam, a project called End the Pain has been running for the past three years to spread the therapy among victims of landmines and leprosy sufferers. It has reached over 100 medical practitioners so far and has also extended the project to amputees in Cambodia and Rwanda.
The simple therapy has proven useful with other syndromes that have perplexed doctors such as Complex Regional Pain Syndrome, a term for unexplained pain. And at the Royal National Hospital for Rheumatic Diseases in the UK, an associate of Ramachandran, Professor Candy McCabe is testing the use of mirrors with acute stroke victims.

Though it is in its very early stages, the experiment into arthritis at UCSD could provide the broadest use of mirror therapy yet.
Much of Ramachandran's work since developing mirror therapy has focused on mirror neurons. He believes these neurons help us understand not only what is happening to our own body, but also to others. They are the basis of empathy, he suggests, our ability to feel what others feel.

In 2009 he used the phantom limb again to provide evidence for this theory, showing that sufferers could experience relief from phantom pain merely by watching someone else massaging or flexing their own hand.
While others spend million on machines with complicated acronyms, the beauty of Ramachandran's work is that he uses ordinary items such as mirrors, pens and paper.