




12-5-2018

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Mirror Therapy, A Pain Management Therapy

Published by Gabriella Andrews

Undergraduate Honors College Thesis

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## Introduction

This project was undertaken to explore the use of mirror therapy (MT) as a palliative for stroke patients and amputees experiencing phantom limb pain. MT is a relatively new treatment and while it has limited research, it is starting to be used more within the rehabilitation setting. Research suggests MT has beneficial effects occur with phantom limb pain as well as post-stroke patients. This study will explain the history, uses, and research behind MT not only as a form of therapy but also a non-medicinal pain reliever.

Included are interviews from physical therapists (PT) and occupational therapists (OT) along with their opinions and personal experience on the uses and benefits of MT. These interviews are a key component of this systematic review due to the real-world experiences the practitioners provide. Experiences from practitioners can either credit or discredit results found in the literature.

### Background: The Invention of Mirror Therapy

In today's society the use of pain pills to contend with physical pain has skyrocketed. The literature suggests that MT provides a successful way to manage their pain without using medication. Vilayanur S. Ramachandran was interested in what can end our addiction to pain medication, and in 1995-1996 he found an alternative form of pain relief.

Ramachandran invented MT to help relieve the phantom limb pain (*Physiopedia*, 2017). Phantom pains occur post amputation when the patient has a strong sensation of feeling pain in that amputated limb. MT can alleviate pain of limb-amputated patients' who experience a pain sensation in the missing limb (Park, Chang, Kim, & Kim, 2015, p. 1681). After the use of MT, the pain of these amputated patients was noticeably diminished (Park, Chang, Kim, & Kim, 2015, p. 1681). MT works by placing a mirror between the involved limb and the uninvolved

limb with the mirror facing the uninvolved limb. The patient partaking in MT, looks at the image in the mirror and moves the uninvolved limb while imagining its reflection as the involved limb.

Vilayanur Ramachandran with the help of his colleague, D. Rogers-Ramachandran, first created MT as a “virtual reality box” (Ramachandran & Rogers-Ramachandran, 1996, p. 377). It was a two-foot by two-foot box encasing a vertical mirror. The top of the box is open, and the patient’s arms were placed inside the box enabling the patient to view their uninvolved hand. During their original study, Ramachandran and Rogers-Ramachandran evaluated patients’ experiencing phantom limb pain ranging from 19 days after amputation to nine years after amputation (Ramachandran & Rogers-Ramachandran, 1996, p. 379).

Ramachandran and Rogers-Ramachandran (1996) found that new neuro pathways can be created in adults after three weeks. These new pathways were found by magnetoencephalography (MEG) which is a way to map the brain activity. It is similar to an electroencephalograph (EEG) of the heart, however the MEG is of the electricity moving through the brain.

Ramachandran and Rogers-Ramachandran (1996) reported four main conclusions from their research. First, the “referral of sensations from intact arm to the phantom implies new pathways can emerge in the adult human brain in less than three weeks” (Ramachandran & Rogers-Ramachandran, 1996, p. 386). Second, through use of the mirror box we can explore the “intersensory effects in phantom limbs” (Ramachandran & Rogers-Ramachandran, 1996, p. 386). Thirdly, movements within phantom limbs can be seen immediately, such as relaxing a contracted hand. Lastly, three one-hour sessions resulted in decreased pain sensations over the course of three weeks (Ramachandran & Rogers-Ramachandran, 1996, p. 386). These conclusions provide a clinical assessment that amputated patients’ have the ability to regain lost

nerve sensations. Research presented by Ramachandran and Rogers-Ramachandran (1996), indicates positive outcomes resulting from only a few MT treatment sessions.

### **Literature Review**

Since the 1990's MT has sparked curiosity in a variety of researchers who's aim is to alleviate pain sensations in post stroke patients. As a cost-effective treatment, MT offers clinicians an easy-to-use and low-cost supplemental therapeutic technique (*Physiopedia*, 2017). Park et al. (2015) found that "at least 85% of stroke patients experience hemiplegia and upper-extremity function of at least 69% of patients is damaged" (p. 1681). Losing potentially 69% of upper extremity function severely challenges activities of daily living such as getting dressed, showering, and making food for yourself taking care of dependents under you.

Patients experiencing deficits within their body, such as muscle atrophy or amputation, that partake in MT allows their brain to focus directly on the limb that was affected. When MT is used for hand pain, patients feel as if their hands are both moving simultaneously due to the reflection of the uninvolved limb in the mirror. This symmetrical movement the patient sees in the mirror is controlled by the cerebral hemisphere (Park, Chang, Kim, & Kim, 2015, p. 1681).

Park et al.'s (2015) study included patients with upper extremity deficits who underwent MT sessions compared to patients who exclusively received therapeutic exercises (p. 1683). Results indicated that the mirror group improved significantly in their ability to execute activities of daily living compared to the control group (Park, Chang, Kim, & Kim, 2015, p. 1683). This supported the finding that supplementing MT in addition to exercises can improve living conditions for patients' who experienced functional deficits.

MT increases the spinal and cortical motor excitability due to what the patient sees in the mirror (*Physiopedia*, 2017). Mirror neurons are the sensations within the brain which comprehend movement patterns and enable us to understand our surroundings.

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. (*Physiopedia*, 2017).

### **Mental Practices**

Caires et al. (2016) found that mental practices in conjunction with mirror therapy work provided better results than MT alone (Caires et al., 2016, p. 1024). When partaking in daily tasks we do not directly think about the energy and work used to perform tasks. If someone loses their ability to react and reflexively move, they have to focus their mind to accomplish tasks. Mental practices in mirror therapy (MPMT) can increase improvements within patients with either stroke or phantom limb pain because of how the brain works. Using motor imagery can be described as “imagining oneself under- taking the skilled movement without actually doing the movement” (Caires et al., 2016, p. 1024).

In addition to MT, MPMT may accompany the therapy process. Once this has been added, the patient closes their eyes and imagines their injured limb moving without pain. This turns on the mirror neurons. Enabling them to start picturing their limb healing and returning to its normal function. MT can be used before or after MPMT has been practiced. The combination of MT and MPMT has been found to increase proprioceptive input and activation of mirror neurons (Caires et al., 2016, p. 1024). Combining MT with mental practices creates greater

muscle activation than using MT alone (Caires et al., 2016, p. 1026). Using MPMT techniques is more difficult than actually moving the body (Caires et al., 2016, p. 1026). Once a person has deficits within your body, they grow accustomed to those deficits and weaknesses. It is extremely difficult to forgo those familiarities and alter what you physically see. Since we rely on our sense of sight more than anything else, tricking your mind is easier said than done.

Xu et al. (2017) demonstrated MT improves the grip strength, range of motion, movement speed, and hand dexterity in stroke patients (p. 1584). MT also helped improve motor function in the tissues surrounding the removed limb and activities of daily life (Xu et al., 2017, p. 1589). Amputation patients may experience depression. As medical professionals, we must remind them that continuously moving their legs or involved limbs can be more beneficial than maintaining a negative mindset (Xu et al., 2017, p. 1589). It also falls under our responsibility as medical practitioners to provide the positive enforcement they need to continue with treatment and exercises, so we do not see regression.

### **Neurological Deficits**

Typically, the largest neurological deficits are seen in stroke patients' arms. Arm paresis is most common because of the loss of sensation and strength due to damage to motor neurons within the brain. These motor neurons can be enhanced by taking patients through sessions of MT. Research has shown patients will improve sensory function after going through bouts of MT (Thieme et al., 2013, p. 321).

Electrical stimulation is a common form of therapy treatment used to reeducate musculature and to enhance correct contractions needed for functional movements. Xu et al. (2017) had patients participate in a ten-meter walk test and results showed significant improvements between groups that received MT in conjunction with electrical stimulation

compared to the groups that only received MT (p. 1583). Electrical stimulation aids in patients who specifically struggle with drop foot along with other mobility and spasticity after a stroke (Xu et al., 2017, p. 1589). The addition of electrical stimulation to the treatment plan will allow patients to improve their gait.

### **The Practitioner's Perspective: Methods**

After researching MT, I began formulating questions regarding the common uses and affects MT has on patients. I decided to turn to the physical therapists and occupational therapists who use MT in their practice. These practitioners offer personal, nonbiased experience to this study. While it is great to abide by the literature, I wanted to dive deeper and explore how MT is being used on the ground. Is it being used the same way as the literature intended?

These practitioners interviewed were licensed PT or OTs, and had knowledge and experience with MT. I contacted eight clinics in Michigan and asked if any of their employees that fit my requirements were interested in being interviewed. After contacting seven different clinics, six therapists replied and were willing to help.

The six interviews took place over the phone, for privacy purposes we will name these practitioners P-1 through P-6. Each interview included nine questions (see appendix A) for the therapists. Answers were recorded while conducting the interview.

Questions asked included how therapists were informed about MT, what patients diagnosis were, positive and negative results of MT, and if they would recommend the use of MT to other practitioners based on their findings. The purpose was to connect current practice to the current literature.



## Results

There was a wide variety of responses, in response to the questions of how they first heard about MT. Word of mouth was the most common way therapists learned about MT. Other sources of information were places are the following; conference, reading about it in pain magazine, research articles, graduate students, and continuing education courses. One common finding was that no one learned about it in their undergraduate or graduate studies.

Next, I inquired how many patients these therapists have used MT with, and what was the doctor's diagnosis that prompted these practitioners to use MT for additional aid. The average number patients were two: however, the diagnosis was always pain or complex regional pain syndrome (CRPS). P-2 and P-3 were OT's, that had experience with patients with amputated digits experiencing phantom pains.

These OT's, which were both from the same clinic, spoke of one patient who was feeling severe phantom pain in an amputated digit. After performing MT by using a mirror box, the results astounded the therapists. P-2 stated, "He looked in the mirror and it looks like he had to normal hands. It was really profound for him". Practitioner 4 and 5 both used MT for post-surgery patients that were relearning proper movement patterns. The mirror provides a biofeedback on how the patient is moving, which allows them to correct wrong movements and to prevent further injuries.

None of the practitioners have used modalities, such as electrical stimulation and ultrasound, in conjunction with MT. However, I did obtain information on graded motor imagery. This technique begins with showing the patient images first and seeing how fast they can distinguish the pictures of left side or right side of the body. When someone displays a slow reaction time, they are more likely to have chronic pain. This can be done through "giving

patients' old magazines and having them circle the right arms or right legs. After doing this, then MT could be used" (P-1).

I learned about "graded motor imagery" in my first interview. Graded motor imagery is the idea of presenting pictures to a patient and instructing them to identify right limbs, or left limbs. This trains their brain to identify the right or left side of the body at a quicker pace. I asked the other interviewees about this topic. Other therapists agreed that there are exercises (graded motor imagery) that come before mirror therapy. These exercises train the brain to block pain sensations. After training the brain to block incoming pain sensations, the brain can then block pain sensations when seeing the body part in the mirror. P-6 stated, "the brain lights up when a patient thinks about getting touched – using MT allows for the brain to not register as much and not light up as much when they're moving in the mirror".

All therapists were in agreement when it came to MT creating positive results. P-4 stated, "when we used graded motor imagery, a girl thought it was hokey and silly at first, but then began to like it and saw our rationale behind why we use it". P-2 also brought up an interesting fact, "when I use it, I felt like we got benefits almost every time there is a benefit. But yet not the miraculous results that Dr. Ramachandran had reported in his research". This is an interesting statement, which makes me wonder how Dr. Ramachandran received such profound results.

None of the therapists experienced negative results.

In general, all the practitioners that were interviewed were in support of the practice and progressive study of MT. P-1 talked about the expense and things to keep in mind when deciding if MT is the best fit. P-3 said, "I would recommend it and certainly now there are more CE courses and protocols. I would highly recommend a therapist adding this to their skill set, because I think it could be very effective especially now with more information that we have

now”. This is important because as time goes on, the research on MT grows. We know a significant amount more now, than Dr. Ramachandran knew when he created MT.

Two therapists were less enthusiastic of MT which could be due to how infrequently they used it. P-4 and P-5 both thought the mirror would be more beneficial for the use of biofeedback form of rehabilitation, instead of MT. Their explanation of biofeedback included patient’s performing daily rehabilitation exercises, such as a body weight squat, in front of a mirror. By using the mirror, the patient is able to observe their body position and correct compensations they may be unaware of. Overall, the results I obtained from these interviews was in support for the practice and progressive study of MT.

### **Discussion**

Limitations on this study include the selection of practitioners interviewed. Results may have changed if a greater selection of therapists were willing to share personal experiences with MT. Limitations also include degree of knowledge at which the practitioners had on MT. Two interviewees had used MT, but not as frequently as others whom were interviewed. In the future, one could interview therapists with at least a certain amount of years of experience with MT.

However, the six willing to talk had great input on the growth of MT. Their real-life experiences became a key component in this study. The participants insights enabled the literature to come full circle into this study. In the future, I believe MT will become part of the curriculum in PT and OT programs as well as be used as a primary resource for patients experiencing severe pain sensations.

Similar to the literature, the interviewees also had positive results after MT was performed. Both literature and interviews showed MT to have substantial gains in decreasing

pain in patients with CRPS along with phantom limb and digit pain. Numerous interviews mentioned graded motor imagery, which was not mentioned in the literature. MT is actually performed last after taking the patient through graded motor imagery work.

This trains the patients' brain to recognize different parts of the body as left or right sided. By doing this, the brain is triggered to recognize exactly what it sees in the images. After performing this with the patient, MT can produce better results since the brain has been trained to believe what it sees. This idea was lacking in the literature that was found.

### **Conclusion**

Since its invention, MT has continued to gain traction in the rehabilitation setting. It began spreading by word of mouth and now classes and symposiums are being taught on MT. This empirical study supported the literature on the benefits of MT. The literature suggested MT has numerous benefits including decreased pain sensations, growth of new neuro pathways, and diminished phantom pain sensation. After completing interviews, the practitioners reported seeing first-hand those same benefits of MT.

By obtaining views of practitioners who have performed this non-traditional therapy, it reinforces positive outcomes that have been found throughout literature. Thus, suggesting MT to be beneficial. PTs and OTs should supplement MT as a therapeutic technique because it not only aids in correcting incorrect form, it is also a form of pain management. After gathering a plethora of information including literature and interviews, MT has shown to create positive improvements on patient's well-being. Regardless of the deficits, or lack thereof, MT provides feedback to its user to positively improve functions of living.

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## Appendix A

## List of interview questions asked

1. How did you learn about MT?
2. How many patients have you used MT with?
3. What were the various physician's diagnoses for the patients for whom you've used MT?
4. What was it about those patients that prompted you to use mirror therapy?
5. Did you use mirror therapy in conjunction with other forms of therapy? (ex. Exercises or modalities etc.)
6. What were the positive results of MT?
7. What were the negative results of MT?
8. What is your overall opinion of the use of MT in your medical practice?
9. Would you recommend MT to another PT's or OT's?