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Seeing Relief: Mirror Box Therapy as a Treatment for Chronic Regional Pain Syndrome

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Seeing Relief:
Mirror Box Therapy as a Treatment for
Chronic Regional Pain Syndrome

May 2016

This evidence project, submitted by
Danielle Watson & Mel Velsher
has been approved and accepted
in partial fulfillment of the requirements for the degree of
Master of Science in Occupational Therapy from the University of Puget Sound.

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Key words: CRPS, Chronic Regional Pain Syndrome, Mirror Therapy

Abstract

In collaboration with an occupational therapist who works in a physical therapy private practice as a hand therapist, the following clinical questions were identified: Is mirror box therapy (MT) effective in reducing pain for patients with complex regional pain syndrome (CRPS); secondary to orthopedic injury or peripheral nerve damage in the upper extremity (UE)? What protocols and dosages are the most effective? A structured review of the literature identified 18 studies that focus on the use of MT for CRPS of the UE: one meta-analysis of systematic reviews, five systematic reviews (SR) and 12 individual studies of which four are not reviewed in the SRs. Research regarding the use of MT for CRPS shows positive effects on outcomes for pain reduction with CRPS Type I, both acute and chronic, and emerging evidence for increased functional use, sensation and decreased swelling. However, currently, evidence is considered of low quality due to small sample sizes and replication by the same research group. Protocols are highly variable and sometimes vague, but the most commonly researched protocol has been L. Moseley's graded motor imagery (GMI) program.

The following knowledge translation products were selected in collaboration with the clinician: an in-service for clinicians and educational pamphlet for consumers. The clinician expressed satisfaction with the pamphlet and regret that we could not schedule the in-service. Further research evaluating the effectiveness of the different protocols and dosages available is recommended, as well as describing the experiences of both the clients and clinicians utilizing MT.

Executive Summary

Our initial meeting with clinician Cathy Elvins, OTR/L, CHT of Northwest Sports Physical Therapy, identified several potential research questions. As a practicing hand therapist, Ms. Elvins has used mirror therapy to treat clients with Chronic Regional Pain Syndrome (CRPS), has found it to be effective, and was interested in the evidence regarding this treatment. In collaboration, we decided the following questions would best fit the scope of this project:

1. Is mirror box therapy effective in reducing pain for patients with CRPS secondary to orthopedic injury or peripheral nerve damage in the upper extremity?
2. What protocols and dosages are the most effective?

We performed a systematic search of several databases for conformity to inclusion/exclusion criteria. Inclusion criteria consisted of CRPS of either type of the upper extremity. Studies excluded dealt with CRPS in LE only or secondary to amputation or CVA. Eighteen studies were identified: one meta-analysis of systematic reviews, five systematic reviews (SR), and 12 individual studies of which four are not reviewed in the SRs. Although 18 studies were found, there was consistent overlap of the studies. The meta-analysis included one of the systematic reviews regarding MT and CRPS included in our critically appraised topic (CAT). Of the 12 individual studies identified, eight were reviewed one or more times in the five systematic reviews. Only four were not included in any of the systematic reviews (See Appendix A for diagram of research overlap).

The results of our critically appraised topic (CAT) show that, currently, the research regarding the use of mirror therapy demonstrates positive effects on outcomes for pain reduction in patients with CRPS Type I, both acute and chronic. Evidence is promising for positive effects on outcomes for increased functional use and sensation as well as decreased swelling, although

currently there is not enough research to draw a conclusion. Only two studies included patients with CRPS Type II, and five out of 12 individual studies included patients with chronic CRPS. Studies either mentioned no adverse effects of mirror therapy or did not address adverse effects. Although positive, the evidence for mirror therapy and CRPS is considered of low quality due to small sample sizes and replication by the same research group. This conclusion is based on a Cochrane review on treatments for CRPS (O'Connell, Wand, McAuley, Marston, & Moseley, 2013), and our ratings based on the AOTA evidence levels and the Tomlin and Borgetto (2011) research pyramid.

Published protocols are highly variable. Of the 12 individual studies identified, nine different protocols were used. The most commonly used protocol has been L. Moseley's graded motor imagery (GMI) program, appearing in four studies (Moseley, 2004, 2005, 2006; Priganc & Stralka, 2011). Studies that differed included cognitive behavioral therapy (CBT), prisms, and/or differences in phases of treatment, duration of treatment sessions and length of intervention. One study did not identify the protocol used. A few of the studies demonstrated positive results when clients repeated the protocol frequently with a home program. Home program protocols vary from as frequently as participants wished to three times a waking hour.

The results of this research were presented to our collaborating clinician and several ideas for potential knowledge translation interventions were presented. Ms. Elvins identified the need for an in-service for clinicians practicing in her facility and an educational pamphlet for distribution to clients with potential to benefit from this treatment. We designed a pamphlet introducing mirror therapy, summarizing the evidence and the most frequently used GMI protocol, and included instructions on how to build one's own mirror box. We created an in-service presentation with a slide show but ultimately were unable to schedule it with the clinician

due to the busyness of their clinic and staff. We evaluated the outcome of our knowledge translation with a survey that was completed by Ms. Elvins. Ms. Elvins was provided with approximately 25 copies of the pamphlet, and expressed satisfaction with the process of the entire project as well as the finished product. She also expressed regret that we were unable to schedule the in-service, and we shared our presentation slideshow with her. The survey completed by Ms. Elvins revealed that our research validated the treatment she has been providing. Ms. Elvins reported that she is interested in participating in additional projects in the future and would recommend the process to other clinicians.

Critically Appraised Topic (CAT)

Focused Question:

Is mirror box therapy (MT) effective in reducing pain for patients with complex regional pain syndrome (CRPS) secondary to orthopedic injury or peripheral nerve damage in the upper extremity (UE)? What protocols and dosages are the most effective?

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Date Review Completed:

2/21/16

Clinical Scenario:

A certified hand therapist often treats clients with CRPS and has found mirror box therapy to be effective at reducing pain. She would like to know if this treatment is supported by evidence. She would also like to know what is the optimal procedure, intensity, frequency, and duration of intervention with mirror box therapy. CRPS most commonly effects women in middle adulthood. It has been estimated that the female: male ratio is 4:1 with a median age of 46 years at onset. The incidence rate has been estimated at 5.46 per 100,000 person years at risk, and a period prevalence of 20.57 per 100,000. An antecedent event was noted in all cases, with fracture being the most common (46%) (Sandroni, Benrud-Larson, McClelland, & Low, 2003).

Review Process

Inclusion Criteria:

CRPS of the UE, preferably secondary to orthopedic trauma, peripheral nerve damage, and/or patients that would be seen by a hand therapist (occupational or physical therapist). Any study type of any year were included. All studies found had been translated into English. If both UE and LE were studied, only studies which analyzed data for the upper limb separately were included. If other treatments were studied in addition to MT, only those studies which analyzed MT separately were included.

Exclusion Criteria:

Lower extremity (LE) only, pain from amputation, CRPS secondary to CVA, orthopedic injuries not resulting in CRPS

Search Strategy

Categories	Key Search Terms
Patient/Client Population	CRPS, shoulder hand syndrome, reflex sympathetic dystrophy, causalgia, upper extremity, upper limb
Intervention (Evaluation)	mirror therapy, mirror box therapy
Comparison	<i>N/A</i>
Outcomes	<i>N/A</i>
Databases and Sites Searched	
AJOT	
BJOT	
CJOT	
OT Search	
OT Seeker	
PubMed/ Medline in UPS databases.	
PEDro	
CINAHL	

Quality Control/Peer Review Process:

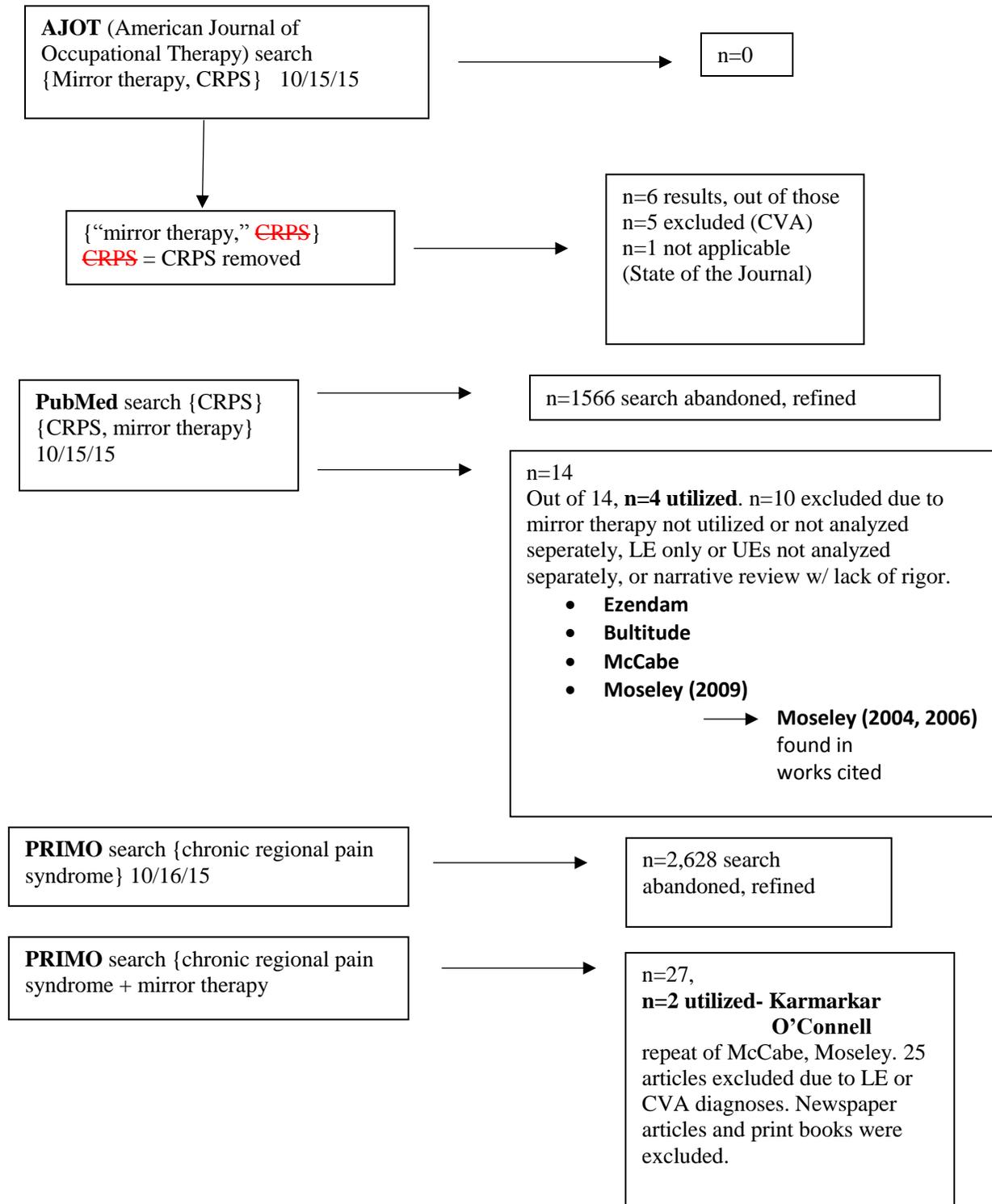
The search process for our topic began with an interview with our clinician. After agreeing on mirror therapy (MT) as our topic, we set parameters for our search. Parameters include clients with chronic regional pain syndrome of the upper extremity- secondary to an injury other than CVA, and excluding pain from amputation, which is commonly treated with MT. Searches based only on mirror therapy and CRPS yielded over 500 results, of which, 18 were selected for review. Of those, 13 were used as studies to be evaluated and presented.

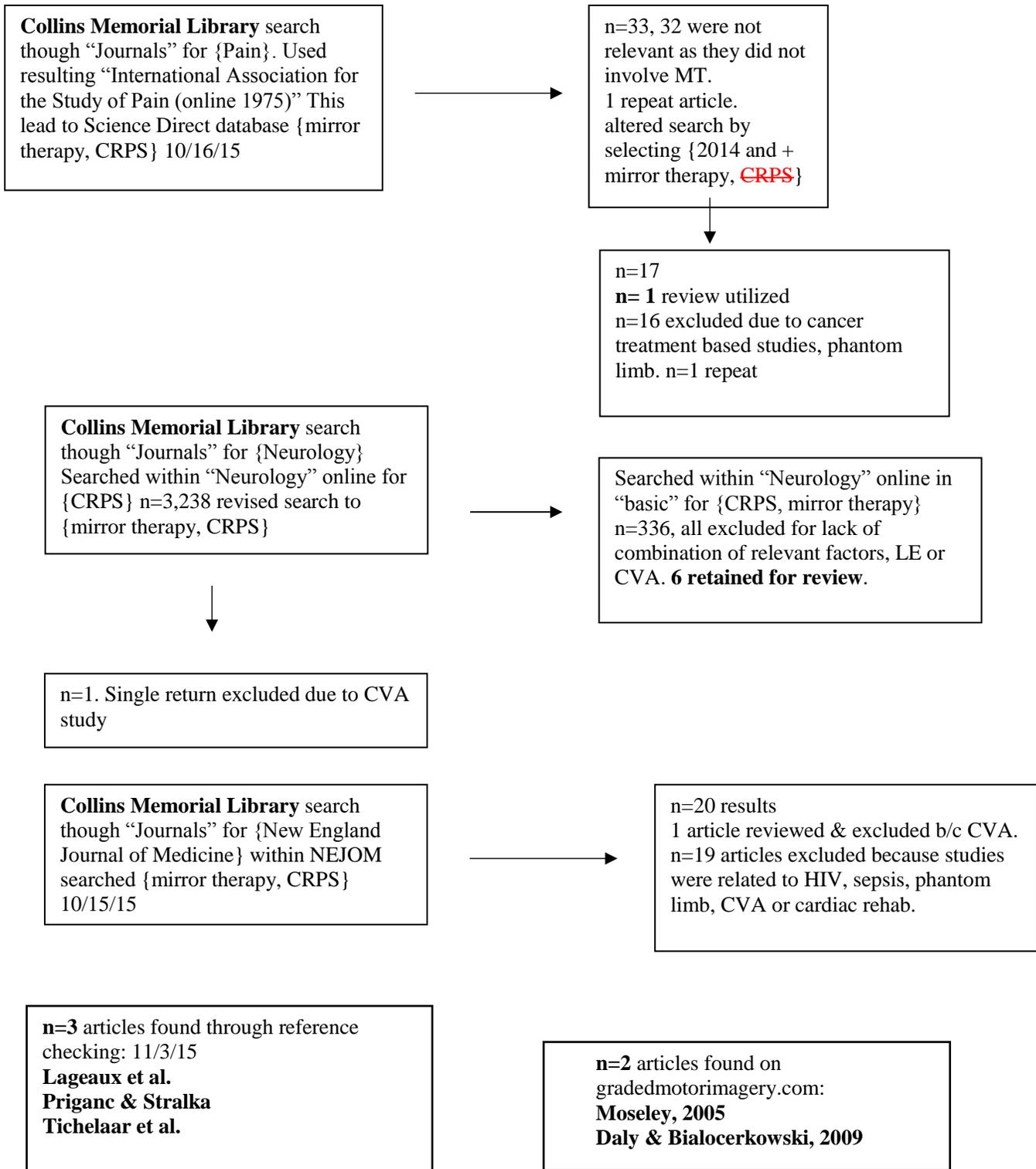
During the search, parameters were adjusted in real time by year of publication, journal title, database, key concept phrasing, peer review and inclusion or exclusion of a key phrase if results revealed too many hits or conversely not enough hits. Adjustments to searches are reflected in the flow chart which reveals strike through and exact word entry utilized for each database. Adding “mirror therapy” to “CRPS” was the most common way to reduce hits, while adding “CRPS” to mirror therapy tended to yield too many. Of the 18 articles evaluated, 2 were excluded based on their inclusion of CRPS secondary to CVA and amputation; these studies did not meet inclusion criteria as those diagnoses were not included in the original research question. These exclusions are defined in the CAT provided. Three articles were excluded as they focused on lower extremity specific conditions that did not add value to our

study or match the original research intent. Of interest in our search was information and articles collected via other studies. Many articles were identified by reviewing the authors' cited works within articles that were chosen for retention. Other source of information were the hard copy journals provided in the Collins Memorial Library. Two more articles were found during the revision process from researching the specific graded motor imagery protocol and discovering the resources on the website for this protocol (gradedmotorimagery.com). Evidence was ranked based on the based on the AOTA evidence levels and the Tomlin and Borgetto (2011).research pyramid

Key contributors to our search strategy and process include group mates, professors, project chair/faculty mentor Sue Doyle, our clinician Cathy Elvins, science library liaison Eli Gandour-Rood and other library staff. Programs that aided us in article search and retention were RefWorks, EasyBib and Collins Memorial Library "ask a librarian" service. Professor Doyle as well as library liaison were met with in person for strategies and topic clarification.

Search Method





Total articles meeting inclusion criteria=18

Results of Search

Summary of Study Designs of Articles Selected for the CAT Table

Pyramid Side	Study Design/Methodology of Selected Articles	Number of Articles Selected
Experimental	<u>6</u> Meta-Analyses of Experimental Trials <u>3</u> Individual Blinded Randomized Controlled Trials <u>1</u> Controlled Clinical Trials <u>1</u> Single Subject Studies	11
Outcome	___ Meta-Analyses of Related Outcome Studies ___ Individual Quasi-Experimental Studies ___ Case-Control Studies <u>3</u> One Group Pre-Post Studies	3
Qualitative	___ Meta-Syntheses of Related Qualitative Studies ___ Small Group Qualitative Studies ___ brief vs prolonged engagement with participants ___ triangulation of data (multiple sources) ___ interpretation (peer & member-checking) ___ a posteriori (exploratory) vs a priori (confirmatory) interpretive scheme ___ Qualitative Study on a Single Person	0
Descriptive	___ Systematic Reviews of Related Descriptive Studies ___ Association, Correlational Studies ___ Multiple Case Studies (Series), Normative Studies <u>4</u> Individual Case Studies	4
Comments:		18

Table Summarizing Systematic Reviews

Author, Year	Study Purpose	Study Design/Participants	Pyramid Evidence Level	AOTA Evidence Level	Sample Size	Interventions & Outcome Measures	Summary of Results	Study Limitations
O'Connell, Wand, McAuley, Marston, & Moseley, 2013	To summarize evidence from Cochrane & non-Cochrane systematic reviews of effectiveness of therapeutic interventions for treating pain & disability in adults w/ CRPS	Experimental: Meta-Synthesis of Systematic reviews- 6 Cochrane (RCTs only) & 13 non-Cochrane systematic reviews were included (Yes on 3 rd criterion of AMSTAR tool required). Only 1 involved MT (Rothgangel, 2011)	E1	I	1 MT specific. CRPS +MT: N=62	Intervention: 6 wk Graded Motor Imagery (GMI) and Mirror Therapy (MT) program. See next entry for details. Rothgangel outcomes: Pain (VAS), Function: 11 item NRS about how well they can perform task that they performed prior to injury but now found difficult b/c of pain. Followed Cochrane Protocol	Authors conclude that only low or very low quality evidence is available from which no firm conclusions should be drawn regarding the use of mirror therapy. MT may be effective for post-stroke CRPS. MT + GMI: Pain: Pooling of CRPS pts gave effect size of -14.45 (95% CI -23.02 to -5.57, P=0.001) on a 0 to 100 VAS. Equated to 25% reduction in pain intensity @ 6 wks. F/U produced effect size of -21.64, equating to 37% reduction in pain intensity at 3-6 months. Exceeded IMMPACT threshold for min-mod important benefit (15%) Function: Mean difference of 1.90 and 2.69 @ F/U = Large improvement in function.	Limited systematic reviews to include. Addresses multiple interventions, diagnoses. No studies reported adverse effects. Limitations of the methodology of this study are that many research studies were excluded due to the extremely high standards set forth by Cochrane review.
Rothgangel, Braun, Beurskens, Seitz, & Wade, 2011	Evaluate clinical aspects of mirror therapy (MT) interventions after stroke, phantom limb pain, and complex regional pain syndrome (CRPS).	Experimental: Systematic Review: 2 investigators searched Cochrane Database of controlled trials, PubMed/MEDLINE, CINAHL, EMBASE, PsycINFO, PEDro, RehabTrials & Rehadat. 21 of 791 articles were reviewed. Included: Moseley, 2004 & 2006	E1	I Rated: 10 class I 11 class IV. CRPS specific: 2 class I, 3 class IV.	21 studies from 1999-2009. 5 CRPS specific. N=62	Interventions w/ CRPS: Unilateral pain-free mvmts of unaffected limb in first weeks. MT preceded by cognitive tx strategies i.e. GMI. Several sessions per day. Outcome measures: Visual Analog Scale (VAS), Neuropathic Pain Scale (NPS), use of pain relief. Details of individual studies included in table below. Evaluated study quality.	For CRPS type 1, MT alone or w/ GMI showed positive results in all 4 RCTs. Groups participating in MT & GMI experienced significantly less pain intensity. Case series using MT reported patients experiencing some short or long term pain relief, reduction in pain medication intake. The quality of evidence for patients w/ CRPS is low, so firm conclusions could not be drawn.	Due to heterogeneity of studies and small N the review was unable to ID right target group for MT. Difficulty defining MT & distinguishing short and long-term clinical effects. Heterogeneity of diagnosis or source of CRPS. Limitations of this study include varied diagnoses.

Daly & Bialocerkowski, 2009	Systematic review of evidence on effectiveness of Physiotherapy (manual therapy, electrotherapy, transcutaneous electrical nerve stim, massage & therapeutic exercise) to manage adult CRPS 1	<p>Experimental: Systematic Review- 2007 electronic search of years 1987-2007 in CINAHL, Medline, Embase, ISI Web of Science, Cochrane Library, TRIP database, PEDro, Joanna Briggs Institute.</p> <p>Included: McCabe et al., 2003 (MVF) Moseley, 2004 Moseley, 2005 Moseley, 2006</p>	E1	I	14 articles, representing 11 studies, met inclusion criteria. 4 articles MT relevant. N= 92	<p>Interventions: Explained in detail under respective studies, below.</p> <p>Outcomes: Review calculated Sample size, quality score, and mean change between pre & post tx.</p> Pain intensity (VAS, NPS) Temp difference Finger circumference Function (NRS)	Good to very good quality level II evidence that GMI is effective in reducing pain in adults w CRPS 1. No evidence was found to support tx frequently recommended in clinical guidelines, such as stress loading. Findings support use of GMI. Stress loading is included in clinical guidelines for which there is little evidence. Recommended that PT clinical guidelines should be updated based on the results of this study.	Physiotherapy practice varies worldwide. This article defines it as “Tx of disorders w/ physical agents and methods.” 3 RCTs by one research group. Need to be replicated by others.

Ezendam, Bongers & Jannink, 2009	Systematic review of research regarding mirror therapy in upper extremity function.	<p>Experimental: Systematic Review Studies: 15 Patient categories: 5</p> <ol style="list-style-type: none"> 1. Amputation (2) 2. post stroke (5) 3. CRPS 1 (5) 4. CRPS 2 (1) 5. Hand surgery (2) <p>Included: -McCabe (2003) -Moseley (2004) -Moseley (2006) -Karmarkar (2006) -Tichelaar et al. (2007) -Selles et al. (2008)</p> <p>Dosage, if included in original, is included in this table under that study.</p>	E1	I	Total across study: N=181. 6 studies CRPS specific.	<p>Intervention: MT Outcome: Kinaesthetic sensations Presence of clenching spasms Sensation in the phantom limb Dichotomous measurement of the phantom limb awareness Motor imagery of affected limb NRS measurement ROM/Speed/Accuracy Subjective comments Grip Release time Max shoulder flex, abd., ER Functional reach Cup to mouth time Time to drape towel over shoulder, pick up pen, fold towel Spasticity Jebsen Test of Hand Function Impairment Inventory of the Chedoke-McMaster Stroke Assessment (CMSA) Pain VAS, NPS IRT Unspecified pain scores Questionnaires.</p>	Mirror therapy may be effective for patients with CRPS as well as post CVA. The studies effective for MT for CRPS used Mosely protocol and combined with graded motor imagery. Studies used large variety of outcome measures so unable to compare results.	At the time the article was written, research in mirror therapy was limited. A small number of studies overall contributed to this systematic study. Methodological quality of studies is variable. Variety of interventions & outcome measures.
Perez et al., 2010	The purpose of the study was to develop treatment guidelines for CRPS, including the use of MT	<p>Experimental: Systematic review Studies conducted between 1980 to 2005. Participants: those with CRPS of the UE. Included: -McCabe (2003) -Moseley (2004) -Moseley (2005) -Moseley (2006) -Moseley (2009)</p> <p>Dosage, if included in original, is included in this table under that study.</p>	E1	I	Total studies evaluated =94 MT specific studies=2	<p>Intervention: Drug treatments: Pain medication, physiotherapy and occupational therapy Vitamin increase Tourniquet use Limit operating time Outcomes: (NRS) about 5 activities they performed prior to injury but no longer perform. McGill Pain Questionnaire (MPQ), Pain VAS, Circumference of 2nd & 3rd digits, response time to recognize affected hand, Two-point discrimination</p>	An analgesic ladder is proposed. Other than drug therapy, alternate techniques are encouraged. Specifically, mirror therapy is regarded as “promising.”	Only two studies of the 94 included MT as the Tx for CRPS. Very limited details provided. Focused on all treatment options. Limited details provided.

						(TPD), Infrared thermography (IRT).		
Tran, Duong, Bertini & Finlayson, 2010	Review and summarize evidence from RCT trials of treatment of CRPS.	Experimental: Narrative lit review of RCTs. Participants: Pts w/ CRPS of the UE Included: Moseley (2005) Moseley (2006) Dosage: <ul style="list-style-type: none"> • 6wks • 3x/wk (actual treatment time of MT not specified) 	E1	I	Total # of RCTs=41 N=~1300	Interventions: Dimethyl sulfoxide, steroids, epidural clonidine, intrathecal baclofen, spinal cord stimulation, and motor imagery programs (MIP).	Clear benefits not recorded from any of the chosen therapies. Implications: more RCTs need to be conducted.	No exclusions of studies were made, regardless of blinding, power, or outcomes. Incorporated motor imagery w/ MT

Table Summarizing the Quantitative Evidence (by level of evidence)

Moseley, 2006	To investigate whether Graded Motor Imagery (GMI) would reduce pain and disability for a more general CRPS I population and for pts w/ phantom limb pain	Experimental: Single blinded randomized controlled trial. Pts w/ phantom limb pain after amputation or brachial plexus avulsion injury, & pts w/ CRPS I . 18 male, 32 female, average age of 41. Exclusion criteria: any other neurologic, psychopathology, motor disorder, dyslexia, visual impairment, or lived outside immediate metro area. Dosage: 10 min every hour	E2	I	N=51 n= 25, exp. n=26, control	Intervention: GMI consisting of 2 wks limb laterality recognition, 2 wks imagined movements, & 2 wks mirror movements. Mirror phase, pts twice adopted posture bilaterally, using smooth & pain free mvmt. Training load gradually increased. Control: Physical therapy and ongoing medical care. Outcomes: Pt questionnaire w/ numerical rating scale (NRS) about 5 activities they performed prior to injury but no longer perform. McGill Pain Questionnaire (MPQ), VAS.	Statistically significant decrease in pain and improvement in function of tx group, gains maintained at 6 month follow up. NNT for pain <=3, for function ≥5. Participation in HEP, 75%.	Not just MT. How long post injury not available. Heterogeneity of sample may have contributed to 50% less pain reduction than earlier studies. Different mechanisms may underlie these different pathological pain disorders. Design may conceal stronger effects in one group than another. Underpowered to systematically evaluate different diagnostic groups.
Moseley, 2004	Would preceding mirror therapy w/ motor imagery	Experimental: Single blind randomized controlled trial w/ control group cross-over. Pts w/ chronic CRPS I 2° to non-complicated	E2	I	N=13 n=6, exp. n=7 control	Intervention: 6 wk MIP: 2 wks recognition of hand laterality, 2 wks imagined hand mvmts, & 2 wks MT. MT consisted of 20 pictures of imagined hand mvmts, each	MIP can improve pain & swelling in pts w/ chronic CRPS I. MIP is more effective than ongoing medical management. Pain & swelling significantly	Not just MT. Limited generalizability. Only CRPS I initiated by non-complicated wrist

	program (MIP) w/o limb mvmt reduce pain & swelling in pts w/ chronic CRPS I?	wrist fracture, 6 mos post. Exclusion criteria: previous benefit from intravenous regional sympathetic blockade, any other UE pathology, any neuro or motor disorder including dyslexia, visual impairment, psychopathology, invasive analgesic strategy, or lived beyond immediate metro area.				waking hour pt advised to slowly & smoothly adopt posture shown 10x while focusing on reflection. Advised to stop if any increase in pain. Outcomes: NPS, circumference of 2 nd & 3 rd digits, response time to recognize affected hand.	decreased in intervention group, as well as control group when they crossed over to MIP. 6 wks post MIP, 50% pts no longer fulfilled diagnostic criteria for CRPS I and NNT to gain 50% pain reduction was 3.	fracture were included. Extensive exclusion criteria. Convenience sample. Patients were not blinded to tx group. No long term follow-up.
Moseley, 2005	To determine the mechanism behind reduction of pain & disability for CRPS I pts participating in a MIP program, the order of MIP components were different for 3 groups.	Experimental: Single blind randomized controlled trial. Pts w/ chronic CRPS I 2° to non-complicated wrist fracture, 6 mos post. Exclusion criteria: previous benefit from intravenous regional sympathetic blockade, any other UE pathology, any neuro or motor disorder including dyslexia, visual impairment, psychopathology, invasive analgesic strategy, or lived beyond immediate metro area.	E2	I	N=20 3 groups Group 1 (MIP) n=7 Group 2 n=6 Group 3 n=7 Female=24 mean age=34	Intervention: 6 weeks, 2 weeks each phase. 3 groups. Group 1- typical MIP program: Hand laterality recognition (Rec), imagined movements (Im), mirror movements (Mir) (RecImMir), Group 2: ImRecIm, Group 3: RecMirRec. Outcomes: measured at 6 (end of tx) & 18 weeks (follow up) NPS, NRS of activities reg. performed before fracture 0=unable to perform, 10=able to perform normally.	The effect of MIP is dependent on order of components, suggesting mechanism is sequential activation of cortical motor networks. At 6 & 18 weeks, reduced pain & disability were greater for the typical MIP group (RecImMir) than for the other groups (p>.05). Hand laterality resulted in consistent limited reduction in pain & disability across groups, imagined movements imparted further reduction but only following laterality recognition, MT imparted reduction in pain & disability, but only following imagined movements.	Extensive exclusion criteria created homogenous sample of CRPS I pts, limiting external validity of findings. Other treatment & medication could have effect on outcome. Small N.
Moseley, & Wiech, 2009	Does MT increase tactile acuity in pts w/ CRPS?	Experimental: Controlled Clinical Trial. 2x2 Design. Pts w/ chronic CRPS of hand or wrist.	E3	II	N=10	Intervention: 30-min tactile discrimination training session. Tactile stimulation involving 72 stimuli for 24 minutes under 4 different, randomized & counterbalanced conditions. 16 sessions, 3-4 days between each. Outcomes: Two-point discrimination (TPD). Pain using VAS.	Tactile acuity improved w/ training, and pain was reduced. Pain returned to pre-session levels at 2 day follow up. Intervention improves tactile acuity if pts look toward affected limb, but watched skin of unaffected limb in mirror. Improvement in TPD and pain are positively related.	No control group. Extra effect could have been because mirror was more interesting & engaging than no mirror. Surprise associated w/ feeling but not seeing touch on limb could contribute to effect. Sessions could have influenced each other.

McCabe, Haigh, Ring, Halligan, Wall & Blake, 2002	Evaluate mirror visual feedback (MVF) as an intervention for chronic regional pain syndrome (CRPS)	Outcome: One group, pre/post study. Participants had a confirmed diagnosis of acute CRPS I for no less than 3 wks and no greater than 3 years. 3 male, 5 female. Average age= 33. Dosage: 10 min sessions for 6wks. No device, mirrored surface and non-reflective surface viewing were used by all participants. Participants kept a diary of use as well as pain severity between assessments.	O4	III	N=8	Intervention: Control phase 1 visualization limb movement Control phase 2 non-reflective surface hiding affected limb Intervention phase 1 mirror therapy. 5 min in clinic, how often not specified + 10 min at home as frequently as pt wished. Outcome: Visual Analog Scale (VAS) Infrared thermography (IRT)	MVF was effective pain relief for those with type 1 (early or intermediate) CRPS. If CRPS is treated early after diagnosis, it may be possible to re-establish a pain free link between sensory feedback and motor intention. Chronic CRPS may not benefit from this Tx.	N was limited. Since subjects were asked to perform MVF as frequently as they wished, study results may be limited to those who take greater initiative for self-treatment. No control group.
Sumitani et al., 2008	To classify the qualities of pain and examine whether the potential analgesic effect of MVF depends on these qualities.	Outcome: One group pre/post study. Participants: Experiencing deafferentation pain: 8 due to brachial plexus avulsion or peripheral nerve lesions. Others due to phantom limb pain, tumor, or SCI both upper & lower extremities	O4	III	Total N=22 UE=14 LE=8 Number of participants meeting inclusion criteria N=8	Intervention: 10min 1x/day over a period that was agreed upon on an individual basis. Dosage: First session: 5 min/ one time Subsequent home session no more than 10min, frequency decided on by patient. Outcome: Patient self-rated various aspects of their pain: limb awareness, movement representation of the phantom or affected/paralyzed limb, pain intensity on an 11-point numerical rating scale (0–10) and the qualities of the pain Before (pre-stage) and after (post-stage) a single 10-min MVF procedure, each patient was interviewed.	Visually induced motor imagery by MVF was more effective for reducing deep pain than superficial pain. The pain reducing effect of mirror therapy may depend on the qualities of the pain.	Results are by self-report. Dosage is variable depending on the patient's willingness to participate in the activity and adherence to recommendations. Of the original 22 participants, 2 were UE Peripheral Nerve injury, which meets the inclusion criteria. Limitations include the inclusion of other diagnoses in the study and the additional effect of medications present in the study.
Lageaux et al., 2012	Evaluate effectiveness of GMI as intervention for CRPS Type I	Experimental: One group pre/post study. Participants had CRPS I below the elbow for less than 6 months. 6 female, 1 male, mean age of 45 years. 3 patients had radius fracture, 2 had	O4	III	N=7	Intervention: GMI is a combination of mirror therapy and motor imagery. This intervention had 4 phases, 1-3 weeks/each. 1) Limb laterality recognition task, 2) an imagined limb movement task (motor imagery w/ mirror box,	Significant results for decrease in pain experienced in last 7 days (VAS), improvement in grip force and patient's global impression of change. Perception of UE function (DASH) results increased but	Patients recruited from only one health center. Pharmacological treatment was not controlled for. Authors state they "did not observe

		hand tendon laceration, 1 had decompression of median nerve, 1 developed CRPS after minor sprain.				3 & 4) mirror therapy. 10 mins 3x/day. Pts progressed to next phase when exercises did not cause an increase in pain. Outcomes: McGill Pain Questionnaire (MPQ), grip force, Patient's global impression of change scale (PGIC) Disabilities of the Arm, Shoulder and Hand Questionnaire (DASH) for perception of UE function.	were not significant. No significant reduction in pain using present pain intensity score of MPQ.	significant changes in functional capacities" but do not explain what they mean by this. Did not specify how long intervention lasted. No control group.
Bultitude & Rafal, 2010	Evaluate the effectiveness of MT in combination with prism adaptation therapy	Experimental: Single subject study. 53 yr old woman w/CRPS I 2° to spiral fractures of 3 rd & 4 th metacarpals. 5 months post injury.	E4	IV	n=1	Intervention: MT and prism adaptation. MT described as synchronous bilateral mvmts while viewing reflection of unaffected hand completing full ROM- 2-3x/day for 2 mins. Prism adaptation described as welding goggles fitted with 25-diopter (17°) leftward-shifting Frensel lenses. Pt made 50 alternate pointing mvmts to targets located at arms length & shoulder height 10° to the L & R of midsagittal plane, returning hand to torso between each mvmt. Continued daily at home. 15 wks: 3 wks tx, 2 wks washout, 1 wk unaffected hand tx, 9 wks tx.	MT alone failed to provide lasting pain relief. Full ROM restored and pain diminished to NRS=0 w/ mirror but effects lost as soon as mirror was removed. Pt recovered ability to do functional tasks.	Small n. Cannot isolate effects of MT b/c intervention combined w/ prism adaptation.
Selles, Schreuders, & Stam, 2008	Describe use of MT w/ 2 patients w/ CRPS type II following traumatic nerve injury	Descriptive: Case report 2 pts w/CRPS II: Pt 1-36 yo woman w/CRPS II 2° to neuroma due to glass injury cutting ulnar & median n (6 mos post). Pt 2-33 yo woman 2° to neuroma due to glass injury to common digital nerves of 3 rd & 4 th digit (2 mos post)(neuroma was surgically treated before MT).	D4	V	n=2	Intervention: Patient (Pt) looked at non-painful hand reflected in the mirror for 5-10 mins. Pt imagined that both hands were moving. Then pt was asked to perform bilateral hand movements for 5-10 minutes. Therapist touched uninjured hand. Pt practiced 3-5x/day for 15 mins. Pt 1: 3 wks. Pt 2: 5 mos. Outcome: VAS.	Pt 1: experienced temporary pain relief only during mirror exercises. At 2 yr follow up pt reported that MT helped regain active movement of involved hand which helps w/ADLs. Pt 2 experienced systematic overall decrease in pain. Pt 2 reported using hand more in ADL after 5 mos of tx.	Small n. 2 pts had different lengths of intervention. Methods not clear: What exercises were done? What was level of medication before/during/after tx.

Karmarkar, 2006	Describe use of MT to reduce pain and increase ROM	Descriptive: Case Report 63 yo woman w/ CRPS I 2° to fracture of the scaphoid	D4	V	n=1	Intervention: MT, protocol and dosage not specified.	“immediate and dramatic improvement” in ROM and reduction in pain scores more than 50 %.	Intervention protocol & outcome measures not identified. Very weak evidence due to low internal and external validity.
Tichelaar, Geertzen, Keizer, & Wilgen, 2007	Results of cognitive behavioral therapy (CBT) combined with mirror box therapy	Descriptive: Case Report 3 patients with CRPS type I, 1 patient w/ CRPS in UE: 46 yo woman, 9 years post car accident. Chronic CRPS I in left shoulder, arm, hand, causing flexion contractures. Forearm cold and atrophic. Arm did not feel like it belonged to her anymore.	D4	V	n=3, UE n=1	Intervention: 4-6 week inpatient CBT combined w/ MT. CBT: reconceptualization of pts cognitions re: CRPS I. Week 1: Analgesics reduced or stopped. Week 2: MT 3x/day for 2 cycles of 5 mins. Week 3: MT 5x/day for 2 cycles of 5 mins. Outcomes: Pain-VAS, ROM, muscle strength, areas of allodynia and hyperalgesia.	Patient did not improve in any outcome. Chronic CRPS I may not be susceptible to CBT and MT.	Cases were heterogenous. Unclear whether results were due to peripheral pathology such as contractures & atrophy, or irreversible cortical changes. No control.
Priganc & Stralka, 2011	Demonstrate how GMI can be incorporated into pain mgmt program	Descriptive: Case Report. 57 year old woman w/ CRPS I , 3 months post distal radius fracture on non-dominant hand.	D4	V	n=1	Intervention: GMI program, 7 visits over 4 weeks. 1) Laterality training 4x/day for 10 mins. 2) Visual imaging & MT w/o mvmt. 3) Moving unaffected hand & looking at it in mirror Outcomes: Pain, ROM, measures not specified.	Decreased pain, increased ROM & ability to move the limb. Gains maintained 6 months post, in combination w/ desensitization, sensory re-education, nervous system, cervical & thoracic mobilization, ROM, scapular & UE strengthening. Patient performed all ADLs, including driving & leisure.	Individualized program, not meant to be guideline for clinicians.

Abbreviations Key:

Abd- Abduction

CBT- Cognitive Behavioral Therapy

CMSA- Chedoke-McMaster Stroke Assessment

CVA- Cerebrovascular accident

DASH- Disabilities of the Arm, Shoulder, & Hand Questionnaire

ER- External Rotation

Flex- flexion

GMI- Graded Motor Imagery

IRT- Infrared thermography

LE- Lower extremity

MPQ- McGill Pain Questionnaire

MIP- Motor imagery program

MT- Mirror therapy CRPS- Complex regional pain syndrome

MVF- Mirror visual feedback

Mgmt- management

Mvmt- movement pt- Patient

NPS- Neuropathic pain scale

NRS- Numerical rating scale of pain

RCT- Randomized controlled trial

TPD- Two-point discrimination

Tx- treatment

UE- Upper extremity

VAS- Visual analog scale

Yo- year old

Summary of Key Findings

Summary of Experimental Studies

A Cochrane meta-synthesis of systematic reviews concerning the effectiveness of therapeutic interventions for adults with CRPS has been completed (O'Connell, Wand, McAuley, Marson, & Moseley, 2013). Of the 19 Cochrane and non-Cochrane reviews included in this meta-synthesis, only one involved mirror therapy: Rothgangel, Braun, Beurskens, Seitz, & Wade (2011). Rothgangel et al. (2011) included Moseley (2004 & 2006). Pooled data indicated equated to a 25% reduction in pain intensity at six weeks and a 37% reduction in pain intensity at three to six months post mirror therapy intervention. A large improvement in function was found by using a patient specific task-related functional scale. This was an 11 item numerical rating scale rating how well they can perform task that they performed prior to injury but now found difficult because of pain. However, the Cochrane review concluded that the current evidence available is only low or very low quality regarding mirror therapy with CRPS and therefore no conclusions should be drawn.

Currently, four systematic reviews and one literature review of experimental studies are available. Three systematic reviews state that mirror therapy may be effective but conclusions cannot be drawn without more high quality evidence (Ezendam, Bongers, & Jannick, 2009; Rothgangel et al., 2011; Perez et al., 2010). The Daly and Bialocerkowski (2009) systematic review from Australia compares mirror therapy to other physiotherapy treatments offered for CRPS Type I. This review concludes that there is "good to very good quality" evidence that a graded motor imagery program (of which mirror therapy is a part) is effective in reducing pain in adults w CRPS I (Daly & Bialocerkowski, 2009). Daly and Bialocerkowski state that "findings support the use of graded motor imagery for CRPS I," (2009)

and that evidence does not support other frequently used treatments, such as stress loading. The authors also acknowledge that most quality evidence is from one research group, and must be replicated by others.

Although eighteen studies were found, there was consistent overlap of the studies (see Appendix A for diagram). Of the twelve individual studies identified, eight were reviewed one or more times in the five systematic reviews. Only four were not included in any of the systematic reviews. Outcome measures varied widely. The most universal outcome measures were the NPS and VAS for pain. Other outcome measures included McGill pain questionnaire, NRS for functional activities, temperature, figure circumference, two-point discrimination, infrared thermography, the DASH and other subjective measures.

The Tran, Duong, Bertini, and Finlayson (2010) narrative review of randomized controlled trials echoed the need for more research. These reviews addressed the use of mirror therapy, often combined with graded motor imagery, to address CRPS in multiple populations including those resulting from upper extremity orthopedic fracture.

Of the five individual experimental studies, three are single-blinded randomized controlled trials, one is a controlled clinical trial, and one is a single subject study. Four of these studies, all by Moseley, were included in one or more of the systematic reviews, Bultitude and Rafal (2010) was not. Moseley (2004) found that mirror therapy with a motor imagery program improved pain and swelling in patients with chronic CRPS Type I initiated by non-complicated wrist fracture. At 6 weeks post intervention, 50% of participants no longer fulfilled diagnostic criteria for CRPS I. Moseley (2005) demonstrated that the most effective order of a graded motor imagery program includes a limb laterality training for the first phase, followed by imagined movements, and finally mirror therapy. Moseley (2006) found a statistically significant decrease in pain and increase in function in the treatment group for participants w/ phantom limb pain, brachial plexus avulsion, or CRPS Type I; Gains were maintained at 6 month follow up. However, the number of subjects receiving intervention ranged from 7-25, so evidence is still limited. The Cochrane review rated this evidence as low quality because of small sample size and methodological limitations, although the effect was sustained at follow up. O'Connell et al. (2013) state that the effect "may have moderate clinical significance." There is also the issue of these studies being replicated by the same research group.

One controlled clinical trial is available with a 2 x 2 design in which 10 participants with chronic CRPS rotated randomly through 4 conditions of tactile discrimination training (Moseley & Wiech, 2009). Improvement in tactile acuity and improvement in pain were positively related. The intervention that most improved tactile acuity and pain was found to be looking toward affected limb and watching skin of unaffected limb in mirror. Pain returned to pre-session levels at 2 day follow up.

One single subject study (Bultitude & Rafal, 2010) evaluated the effects of MT and prism adaptation on a woman w/ CRPS I post fracture. Ability to complete functional tasks was recovered but pain relief was not sustained after removal of the mirror.

Summary of Outcome Studies

Three outcome studies, all one group pre-post studies, are available. McCabe et al. (2003) found mirror therapy to be effective for pain relief in participants with CRPS Type I (early or intermediate) of the upper or lower extremity. The Sumitani et al. (2008) study had 22 participants with CRPS, phantom limb pain, or an affected/paralyzed limb of either the upper or lower extremity. Outcome measures included self rating of various aspects of the pain, including but not limited to a numerical rating scale. Mirror therapy was found to be more effective at reducing deep pain than superficial pain, indicating that the pain reducing effect may depend on the qualities of the pain. Lageaux et al. (2012) found significant results for decrease in pain experienced in last 7 days (VAS), improvement in grip force and patient's global impression of change after a graded motor imagery and mirror therapy program.

Perception of UE function (DASH) results increased but were not significant. There was no significant difference using present pain intensity score of MPQ.

Summary of Qualitative Studies

No qualitative studies could be found on this topic at this time. The importance of these data should not be underestimated as they could offer perspectives from both client and therapist alike.

Summary of Descriptive Studies

Four case reports document the applicability of mirror therapy to CRPS. One case report contains two participants with CRPS Type II. One participant experienced pain relief only during the mirror exercises, the other experienced overall decrease in pain. Both participants reported improvement in ADLs at follow up. Another case report did not specify intervention or outcome measures, besides that mirror therapy improved pain score of more than 50% as well as improved range of motion for a patient with CRPS Type I. Priganc and Stralka (2011) reported improvement in a case study of a 57 year old woman with CRPS Type I. The participant experienced decreased pain, increased ROM and ability to move the affected limb. The gains were maintained 6 months post. However, the mirror therapy was in combination with other treatments such as desensitization, sensory re-education, ROM and strengthening. Patient went on to performed all ADLs, including driving and leisure. On the other hand, Tichelaar, Geertzen, Keizer, and van Wilgen (2007) reported a case of a 47 year old woman with chronic CRPS I 9 years post injury that did not improve in any outcome. This indicates that chronic CRPS I may not be susceptible to this combination of cognitive behavioral therapy and mirror therapy.

Implications for Consumers:

For patients with complex regional pain syndrome (CRPS) there is emerging evidence that pain can be reduced with the use of mirror therapy. For these patients, research has also shown that sensation and function can be improved with this treatment. The best evidence in this area supports mirror therapy along with a specific program called a “graded motor imagery program.” Other than this, the research has not concluded which activities in the mirror box are best or how often it should be used. Therefore, this treatment is promising and consumers should consult a hand therapist.

Even though studies have found positive effects of mirror therapy, this research is currently considered low quality. This is because of the limited number of studies and their lack of details regarding their design and specifics of treatment. However, if CRPS is not treated and becomes chronic, there is great risk for loss of function. None of the research showed the use of mirror therapy to result in anything negative. Therefore, we advise the consumer to take advantage of this treatment as early as possible. Mirror therapy should be combined with the variety of treatments a hand therapist can provide.

This review of the research focused on conditions that hand therapists treat. This includes patients with orthopedic (bone and joint) or nerve injuries. Other diagnoses, such as stroke or amputation, were excluded, although mirror therapy has been shown to help these conditions too. Only 2 of the studies looked at patients with CRPS Type II, most looked at CRPS Type I. More studies looked at acute (new) CRPS than chronic (old) CRPS. It is recommended that consumers try mirror therapy as soon as possible after symptoms develop to prevent disuse of the affected limb and to interrupt faulty pain signals.

Implications for Practitioners:

There is emerging evidence that mirror therapy has the potential to impact pain, functional use, sensation, and swelling in persons with CRPS occurring after orthopedic or nerve injury. Given the state of the evidence, it is reasonable for therapists to pursue the use of mirror therapy based on the positive outcomes reported. It is recommended that practitioners document their own methods when the therapy is utilized, and carefully document and monitor the outcomes and patient response. Practitioners should stay up to date with future research to ensure best practice.

The most researched protocol found to be effective in decreasing pain and increasing function for patients with acute and chronic CRPS I is the inclusion of mirror therapy in a graded motor imagery program studied by Moseley (2004, 2005, 2006), and Priganc and Stralka (2011). A modified GMI program was studied by Lageaux et al. (2012). Moseley's GMI six-week program consists of two weeks of practicing recognition of limb laterality, followed by two weeks of imagined hand movement, and then two weeks of mirror-box therapy. Recognition of limb laterality consists of presentation of photographs of hands in various positions and alignments to the participant and they respond by choosing whether the picture shows a right or left limb. The imagined movement phase presents participants with images and they are instructed to imagine adopting the posture shown with a smooth and pain-free movement. Training load increases over time. During the mirror movements participants are instructed to adopt the posture shown with both hands while looking at a mirror box with affected limb inside. Again, movements are smooth and pain free, and training load is increased. The participants are recommended to do these exercises 3 times each waking hour unless they experience pain. The five studies differ slightly on protocol. Participants in the Lageaux et al. (2012) study performed mGMI at home 10 minutes 3x/day, compared to Moseley's (2004) participants who performed GMI three times, equating to ten minutes, each waking hour.

When utilizing this intervention for patients with CRPS, the therapist should adjust dosage to ensure the patient remains pain-free. Across the studies reviewed, that dosage range was 5-15 min, 1-2 times per day to up to 3 times per waking hour, for 3-6 weeks. Six weeks was the most common overall duration. Because of the frequency with which this intervention was repeated in most studies, a home program appears integral to success. More research is needed to hone the optimal and most realistic dosage to be accomplished by a client.

While the studies did not mention adverse effects, therapists should be aware of the potential for adverse effects and monitor their clients carefully. Practitioners should also be aware of the various subsets of CRPS. Only two of the studies included patients with CRPS Type II (Selles, Schreuders, & Stam, 2008; Tichelaar et al., 2007) and the results were mixed. Approximately five studies included patients with chronic CRPS.

Decisions for each patient should be based on the client-centered, therapeutic relationship established with the patient. The theory and benefits of mirror therapy needs to be communicated with other disciplines so that they too can suggest and explain this modality. This is also important for the purpose of advancing the evidence based vision of occupational therapy that promotes reimbursement and a continued place at the table as providers.

In summary, nine different protocols were identified. The most commonly used protocol was L. Moseley's graded motor imagery program (GMI), replicated four times. Of the four studies that used GMI, the most common outcome measures were the Visual Analog Scale (VAS), the Neuropathic Pain Scale (NPS), and a numeric rating scale (NRS) of activities performed prior to injury but no longer able to perform. Results showed statistically significant reduction in pain (VAS & NPS) and disability (NRS). Gains were maintained at follow-up ranging from six weeks to six months post intervention. One study showed that 50% of patients no longer fulfilled diagnostic criteria for CRPS Type I at 6 weeks post intervention.

Implications for Researchers:

There is an obvious need for more high quality research on this topic. This includes randomized controlled trials as well as qualitative research. There is currently no qualitative research regarding the subjective experience of a client with CRPS participating in a mirror box therapy intervention or concerns of the therapists with the use of this modality. The quality of the evidence is currently considered low because of small numbers and lack of description or consistency of protocol. There were nine different protocols in the twelve studies, and one study did not describe protocol at all. This is why a graded motor imagery program is currently the most promising: it is the only consistently described intervention that includes mirror therapy. However, all four of the experimental studies were completed by Moseley et al., therefore the results need to be replicated by other researchers.

Another limitation of these studies is the frequency with which participants repeated this intervention at home. Many studies did not record how often this was accomplished. For those that did report, the frequency of these sessions ranged in the literature from 1x/day to 3x every waking hour. This dosage is not very practical for application to real life situations. The goal of future research should be to target optimal dosage and protocol of this intervention. The optimal intensity, frequency, and duration of intervention with mirror box therapy needs to be addressed by researchers to help practitioners implement this intervention effectively.

In addition, more consistency with outcome measures is needed. At least nine outcome measures were used in the twelve studies, making comparison difficult.

Bottom Line for Occupational Therapy Practice/ Recommendations for Best Practice:

Currently, the research demonstrates positive effects on outcomes for pain reduction in patients with CRPS Type I, both chronic and acute. Evidence is promising for increased functional use and sensation as well as decreased swelling, but currently there is not enough research to draw a conclusion. Overall, evidence is considered of low quality due to small sample sizes and replication by the same research group. Protocols are highly variable. The most commonly used protocol researched has been L. Moseley's GMI program. Occupational therapists can be confident that providing mirror therapy as one intervention for clients with CRPS Type I is considered best practice based on the research at this time.

Barring any emerging evidence that could find adverse effects, clinicians should consider this intervention when they and their client see potential benefit in its use. The existing evidence has shown success when participants repeated the protocol frequently throughout the day. The optimum dosage for this has yet to be found, but compliance with a home program appears to be integral. For clinicians using mirror therapy, it is advised that data regarding mirror therapy protocols used such as duration, diagnoses, dosage, and outcomes be documented and compiled into comparable data. Additionally, it is recommended that if adverse effects of this treatment are encountered, clinicians make a concerted effort to record them in an effort to better understand and establish exclusionary criteria.

Involvement Plan

In collaboration with our clinician, we identified multiple areas for possible knowledge translation to incorporate our findings into clinical practice. Our clinician prioritized these needs, and based on these priorities our team put together a timeline and plan for creating both an educational pamphlet for consumers and an in-service for clinicians. Both would explain best practice based on the current state of research for the treatment of CRPS using mirror therapy. An in-service was requested by our clinician so that knowledge translation could be communicated to her colleagues (see Appendix B for slideshow), and a pamphlet was requested to address the need for greater understanding by the consumers of the MT intervention (see Appendix C for pamphlet).

There are several facilitators and barriers in the organization's contextual factors as well as individual factors that had the potential to effect our knowledge translation activities. The organizational structure of the small private company for which our clinician works allows for adaptability and flexibility, contributing to ease of incorporating new innovations (Palinkas & Soydan, 2012). Larger institutions may have required an intense editing or approval process before our pamphlet could be distributed to the public. We were not required to put a specific logo on the pamphlet or make sure it fit into an existing marketing scheme. Clinician autonomy is another one of the facilitators of ease of knowledge translation. The leadership of this organization is supportive of their therapists' clinical reasoning. The intervention of MT is easily routinized and is sustainable because it is low cost and readily available. An individual factor facilitating this process was that our clinician took part in "participatory decision making" (Palinkas & Soydan, 2012); she was personally invested in this research question and was therefore more likely to implement change.

One barrier to the successful implementation of MT is the need for training. Fixsen, Blase, Naoom, and Wallace (2009) identified in-service training as one of the seven core components of successful implementation programs. We were not able deliver the in-service due to the busy schedule our collaborating clinician and her colleagues. Another barrier to successful routinization of MT in this setting is the lack of efficient data collection and review systems available (Palinkas & Soydan, 2012). “Decision support data systems” (Fixsen et al., 2009), which systematically collect data, are another one of the seven core components. Our clinician stated that she treats clients with CRPS sporadically and does not have a system for comparing their outcomes. Another one of the core components that may be lacking in this situation is a facilitative administration (Fixsen et al., 2012). The organization administration could have facilitated translation and implementation of evidence-based practice by allowing clinicians time in their schedules for meetings with student researchers and an in-service training.

To prepare for designing the pamphlet, we compiled essential information regarding protocols, outcomes, and possible side effects followed when using mirror box therapy as an intervention for CRPS. We then designed a pamphlet using Vistaprint®, a professional printing service and prepared content for in-service presentation with a slide show. Conclusions regarding protocols were derived from our CAT research project, to ensure that we were providing the most frequently replicated and up-to-date protocol for the consumers and clinicians.

The focus of this project was on the “inner context” (Palinkas & Soydan, 2012), or the service delivery level of the individual providers and consumers. Consumers that receive mirror box therapy from the clinic will receive the pamphlet in an effort to increase their understanding of the intervention. Our clinician mentioned that client buy-in is crucial for the success of MT for CRPS. This pamphlet is a valuable translation material since cortical reorganization is a complex

concept and there is potential for misunderstanding regarding mirror box therapy. We were careful not to undermine the client's pain experience by inferring, "it is all in your head." We wanted the pamphlet to validate the client's pain experience by explaining in layman's terms the neurological benefit mirror therapy has for reducing pain and improving function in clients with CRPS. This understanding will hopefully increase client buy-in.

Evaluation of the practical applicability of the pamphlet and the usefulness of the in-service was conducted by a survey completed by the clinician (see Appendix D for survey). Key questions in the survey explored the influence of this collaborative project on treatment strategy or confidence in the treatment, as well satisfaction with the process and likelihood to participate in future knowledge translation projects. The clinician was also asked if she believed other clinicians could benefit from involvement in similar projects. Clinician survey was one page with yes or no questions, and had space for write-in answers as well.

Involvement Plan Schedule

Goal	Date projected	Date Achieved
Confirm w/ clinician priority for project, i.e. informational material for clients or clinicians.	March 11	Feb. 29
Compile information for pamphlet, choose format, create pamphlet draft.	March 18	March 31
Get feedback from Chair regarding product review.	March 25	Emailed draft: March 22 Feedback received: April 3
Present pamphlet draft to Ms. Elvins, get clinician feedback. Create plan for production: how many copies or digital image needed?	March 31	Emailed draft: April 3 Feedback received: April 11
Pamphlet edited and complete.	April 8	April 11
Complete in-service by this date and present printed educational materials.	April 19	Unable to schedule

Outcomes

Barriers encountered while attempting to schedule the in-service with our collaborating clinician and her colleagues were due to busy schedules of all involved. Ultimately, the in-service was e-mailed to the clinician for viewing. Outcomes were monitored for the CAT, brochure, and for the project as a whole.

Upon presentation of the educational pamphlet, our clinician was pleased with the work and detail of the finished product. She spoke of its professional appearance and readability. She expressed regret about not being able to schedule the in-service and was given multiple copies of the finished product to review over several days.

A survey was sent via e-mail two days post-delivery of the pamphlets to rate our clinician's overall satisfaction with the process and product. The completed survey results showed that the project did not influence the way she practiced or provide new information on the topic. Additionally, she stated that the evidence did not increase confidence in the treatment because she had been somewhat aware of the evidence we uncovered. She felt that the pamphlet was appropriate for the audience for which it was intended, and she foresees it being helpful and educational for clients. There were no details she wished to go back and re-visit or questions she felt were not answered. She was interested in participating in similar collaborations in the future and recommended this type of project to other clinicians.

The fact that our clinician treats clients with CRPS only sporadically is a barrier to monitoring effects of this knowledge translation project on consumers. It would be interesting to follow-up on the results of the educational pamphlet on treatment on future clients with CRPS. The clinician stated in the survey that, "people forget what you tell them so having printed material they can take home is very helpful."

Effectiveness of Tasks and Products

Our research team opted to complete two separate but related knowledge translation projects to ensure that our findings could be presented via multi-contextual platforms. Evidence suggests that singular events such as in-service alone are not as effective as combined knowledge translation interventions (MacDermid & Graham, 2009). However, organizational and individual factors served as barriers to delivering our in-service as we were not able to schedule it.

Effectiveness of this project as assessed by our collaborating clinician ranged from neutral to positive. Interestingly, our research served to reinforce treatments that she had already been using, rather than creating new implications for treatment. In person, she expressed satisfaction with the research question and products produced. The results of the questionnaire showed that the project did not influence the way she practiced or provide new information on the topic. However, the project was successful in validating her current methods of delivering the treatment. The questionnaire made clear that the overall process was worthwhile, that she would participate again in the future and recommend the project to other clinicians.

The results of the questionnaire were not surprising, given that the clinician had been using the treatment with a high level of confidence for many years. Because the protocol she follows closely aligns with the most researched protocols, it was also not surprising that her practice was not significantly altered by our findings. The fact that her current methods could be validated however is of high clinical significance. Her original question arose because time had passed since her MT training and she wanted to make sure she was practicing the most up-to-date and researched protocols for this treatment. This confirmation was an essential component that we were able to provide. It is likely that other clinicians would find this information useful, given the variety of protocols in the research.

The amount of time that went into the creation of those products and services allowed for thoughtful revision that resulted in finished products that we are proud of that we believe deliver relevant information. They accurately define the original question as well as the findings. Our CAT was thorough, given the amount of time our team had to complete the initial inquiry and data compilation. The scope of the question allowed us to exhaustively review the research and lent itself to a high degree of thoroughness. The combination of these factors resulted in a highly detailed report that was exhaustive but clear.

The solid foundations of our research question and literature review helped us fine-tune the topic for knowledge translation activities. The pamphlet designed can give clients enough information to introduce mirror therapy and still encourage further discussion with their clinician as well as self exploration of the topic. It is clear, detailed and aesthetically pleasing. Detail is provided with a summary of GMI, the protocol most studied in the research. Lastly, there is a section with instructions on how a consumer may create their own mirror box to use at home. This third stage is important, should the consumer and clinician decide together that mirror box treatment has potential to benefit that client. Ultimately, our expectation was for consumer information to allow for shared decision making which can lead to better clinical outcomes.

Information from our research paper's key findings, summary, and implications for both consumers and clinicians were reviewed and filtered into the most essential information. That information was then further simplified, to ensure that the target audience, namely consumers, would find the information readable. Knowing that the majority of the United States population has a six to seven grade literacy level, we simplified the language. Microsoft Word rated the text of the pamphlet as a Flesch-Kincaid grade level of 8.6.

The in-service presentation, like the pamphlet, reflects clear and concise information,

the language is significantly elevated to reflect the intended audience of clinicians and other professionals. Given that audience, their level of education and the importance of presenting clear conclusions about methods and protocols we included all relevant data and resources used to reach our recommendations. Based on knowledge translation research, and the fact that it is more effective when multiple methods are used (MacDermid & Graham, 2009), we felt strongly that with these two mediums, translation was more likely to occur. There was considerable time spent making sure that our final presentation matched our expectations. We are pleased with the results.

Our overall evaluation of products and services provided is that both platforms were clear and tailored to the audience for which it was intended; without the original message getting lost. Had one individual reviewed both the pamphlet and attended the presentation, we feel that there would have been congruence without overt repetition as well as solid research information and practical application materials for both clinician and consumer.

Given our findings on the current state of protocol, we feel confident that there is now information about the most used and researched protocols and information on what to look for should research regarding the intervention advance.

Analysis of Overall Process

Throughout the research collaboration project, a clear research question and clearly defined plan and objectives helped set the stage for a positive and rewarding experience. This process met the majority of expectations of the researchers. Carrying out the research itself was methodical, systematic and sometimes tedious; as research often can be. At the beginning of the project, when timelines and checkpoints were just ink on paper; it seemed an overwhelming amount of information and tasks to work through. Thankfully, through an organized and

systematic approach, the project itself was very smooth and we felt prepared to meet each deadline.

The initial phase, which was identifying our question, the compiling of data, and examining that data thoroughly, proceeded without interruption. Our team distributed the work load equally and set about reviewing the information, looking for patterns that might emerge. We were then able to piece together our first report which was as time consuming as expected. Having our CAT reviewed by our project chair and then presenting that information to our clinician also ran very smoothly. Timelines were met and meetings were organized. During this time, while scheduling was slightly complex, we did not encounter any major setbacks or surprises. Once our final report was approved, we set to work on creating the pamphlet. Overall, while this piece of the project took up all the time we set aside for it, our team feels that we had enough time to review and edit it several times at a reasonable pace. It was not until the completion of this phase that our experience of the project changed. During the period when we needed to complete time-sensitive aspects of product delivery, the amount of time between correspondence from our clinician doubled. We were unable to complete the in-service because of scheduling difficulties but were able to meet briefly to deliver the pamphlet. Still, we can say that we are overall pleased with the process of the project and the results.

The knowledge translation steps originally seemed far off, and their importance was masked by the fact that we hadn't completed the research yet. Once faced with the possibility of not being able to complete the requested in-service for our clinician, the importance of that translation set in. Overall, the project gave us first-hand experience in researching current evidence, presenting that evidence in a useable platform and, finally, learning to translate that information to those who need it most. While it was unfortunate that we were not able to meet

100% of our goals, it is important to note that we created a slide show presentation that was forwarded to Ms. Elvins and her colleagues to be utilized at any time.

Barriers to this process included communication and coordination of busy schedules. Circumstances prevented us from being able to schedule a time to fully present the results of our work this spring to our clinician. Because knowledge translation and presentation of information in multiple forms is an effective means of transferring knowledge, it would have been beneficial to have had the opportunity to present the results, even in an informal way (MacDermid & Graham, 2009). This should be a real consideration for future graduate student researchers as they navigate the timeline with their collaborators.

Because of these barriers, in the future, we recommend that follow up projects may include a set time that allows for in person meetings between researchers and clinicians to ensure that all questions are answered and that information be addressed. Out of respect for the clinicians and their valuable time and input, we need to ensure that they are able to hear the results of what was discovered. Equally, out of respect for the intrepid researchers, opportunity for knowledge translation should be guaranteed. Working hard to sort and quantify information for the sake of current practice without translation does not lend itself toward AOTA's centennial vision of a stronger base of evidence based practice. In the interest of those who dedicate themselves to the research question of the clinical collaborator, it would seem that clear expectations of at least one translation activity would be expected. In order for research to be fruitful and applied to clinical practice, information obtained through research must have a mechanism for dissemination to those who can apply, scrutinize and/or replicate the results.

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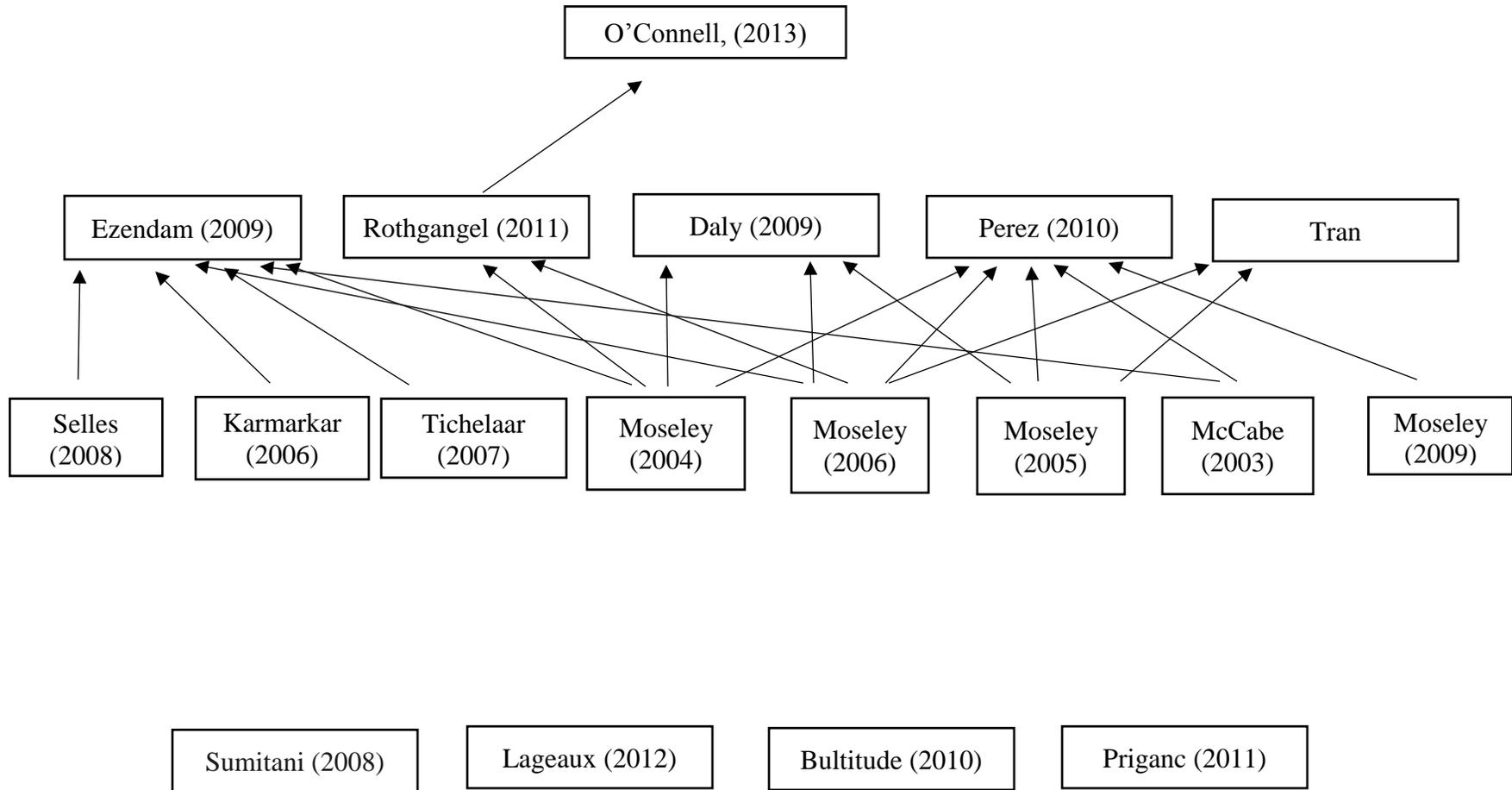
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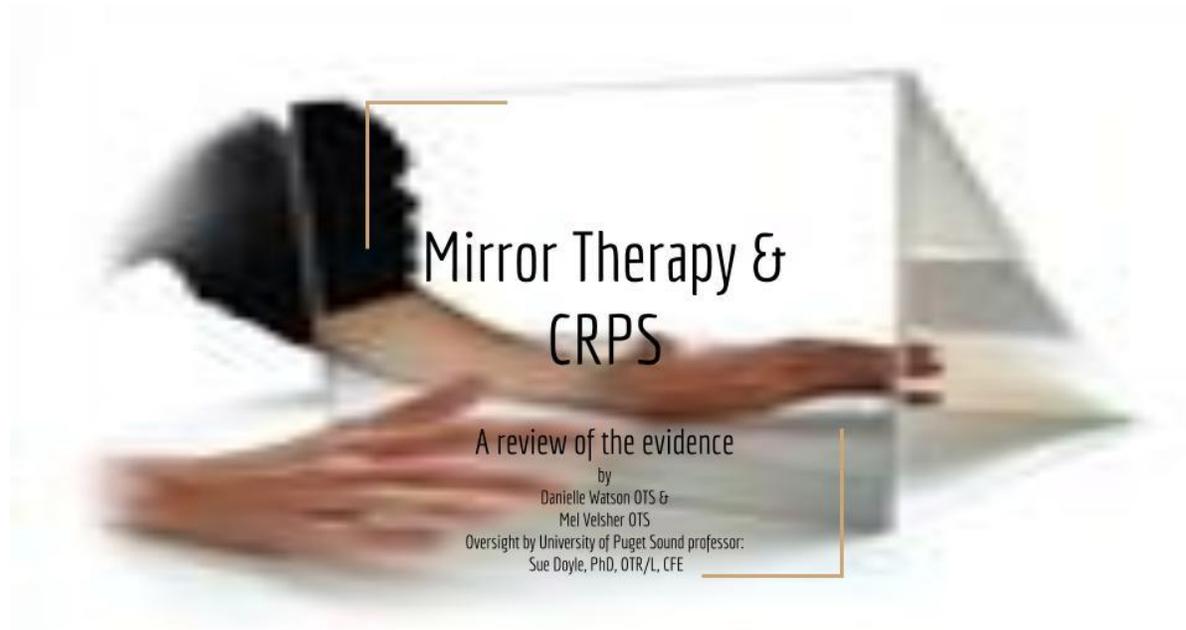
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Appendix A
Diagram of Research Overlap



Appendix B
In-service Presentation for Clinicians



Question:

Is mirror box therapy effective in reducing pain for patients with complex regional pain syndrome (CRPS) secondary to orthopedic injury or peripheral nerve damage in the upper extremity?

What protocol and dosage is the most effective?

Our criteria and search...

Inclusion: CRPS of the UE, preferably secondary to orthopedic trauma, peripheral nerve damage, and/or patients that would be seen by a hand therapist (occupational or physical therapist). Any study type of any year were included. All studies found had been translated into English. If both UE & LE were studied, only studies which analyzed data for the upper limb separately were included. If other treatments were studied in addition to MT, only those studies which analyzed MT separately were included.

Exclusion: Lower extremity (LE) only, pain from amputation, CRPS secondary to CVA, orthopedic injuries not resulting in CRPS

Search: Databases were searched for the following terms: CRPS, shoulder hand syndrome, reflex sympathetic dystrophy, causalgia, upper extremity, upper limb, mirror therapy, mirror box therapy. The following databases were searched: AJOT, BJOT, CJOT, OT Search, OT Seeker, PubMed/Medline, PEDro, CINAHL.

Results

Studies selected that met the inclusion criteria were ranked based on the research pyramid by Tomlin and Borgetto and AOTA Evidence level system.

Pyramid Side	Study Design/Methodology	Number of Articles
Experimental	6 Meta-Analyses of Experimental Trials 3 Individual Blinded Randomized Controlled Trials 1 Controlled Clinical Trials 1 Single Subject studies	11
Outcome	3 One Group Pre-Post Studies	3
Qualitative		0
Descriptive	4 Individual Case Studies	4
TOTAL		18

Bottom Line for OT Best Practice

- Evidence suggests positive results for patients w/ CRPS Type I in the outcomes of pain, sensation, and function.
- Best results when in acute stage
- Evidence is still considered low quality due to study size
- Most studied protocol is Moseley's Graded Motor Imagery Program (GMI)
- 4/18 studies were by Moseley's research group

Consider using mirror therapy for clients w/ CRPS I along with other interventions.

Most researched protocols and outcomes

Protocols:

Summary of Findings:

- Nine different protocols were identified.
- The most commonly used protocol was L. Moseley's graded motor imagery program (GMI), replicated four times.
- Moseley's GMI program is a six week program Two weeks limb laterality training, two weeks of imagined movements, and two weeks MT

Outcome measures:

- Of the four studies that used GMI, the most common outcome measures were: Visual Analog Scale (VAS), Neuropathic Pain Scale (NPS), & numeric rating scale (NRS) of activities performed prior to injury but no longer able to perform.

Results:

- Studies showed statistically significant reduction in pain (VAS & NPS) & disability (NRS).
- Gains were maintained at follow-up ranging from six weeks to six months post intervention.
- One study showed that 50% of patients no longer fulfilled diagnostic criteria for CRPS Type I at 6 weeks post intervention.

So what is the best protocol?

Due to *highly variable* protocols throughout the studies available, it appears that the most common evidence-based protocol is that of Moseley's RCTs.

Additionally, practitioners should note that rarely, if ever, is mirror therapy used in isolation, but instead appears to be most effective when included in a graded imagery program and combined with other evidence-based interventions. Home programs also appear to have an impact in the success of this modality.

What do we tell consumers?

Based on our extensive research, we designed a pamphlet with your clients in mind! We want them to understand mirror box therapy and feel comfortable talking to you about their concerns or questions. Based on our findings, should you choose to request that your client engage in a home program, we have included detailed instructions regarding the creation of a home mirror box for a fraction of the cost of one bought through a medical vendor. We have provided copies of that proof to look over today.

Where do we go from here?

Because of positive but limited evidence, it is advised that data regarding mirror therapy protocols such as duration, diagnoses, dosage, outcomes, and adverse effects be organized and compiled into useable data. This simple action on that part of clinicians aids in advancing AOTA's evidence based vision of occupational therapy that can secure continued reimbursement and a place at the table as valued therapy providers.

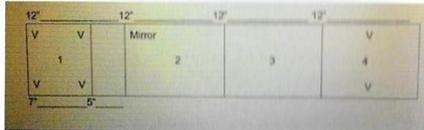
*It is important that key members of any therapy team also be informed so that they too can suggest and explain this modality.

Appendix C Informational Pamphlet for Consumers

Instructions for making your own mirror box:

Supplies needed:

- 48" x 12" piece of corrugated plastic sign material or 12" cardboard box
- 12" good quality mirror. Acrylic mirrors resist breaking (available from plastics store) or mirror tile (breakable. A distorted mirror can do more harm than good.
- Strong glue
- 8" of adhesive backed velcro, cut into 1-2" strips

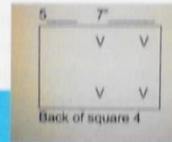


Steps:

1. Fold plastic or cardboard like accordion into (4) 12" segments.
2. Glue mirror to second square.
3. On 1st square, draw vertical line 5 inches from the mirror.
4. Place 4 pieces of 1" female velcro on Square 1 and 2 in the center of Square 4, as indicated in diagram by V's



5. Flip everything over and place 4 pieces of male velcro on the back of square 4, 2 on edge and 2 7" from edge. These correspond with the 4 on Square 1.



6. When square 4 is folded around and stuck to square 1, the mirror box will stand up on Square 3 and the mirror will stand at a 90° or nearly 90° angle.
7. The box can be folded down like an accordion and stored flat; 3 inch male velcro strips can be used to keep it closed.



For more info: <https://www.youtube.com/watch?v=hMBA15Hu35M>

Mirror Box Therapy

A treatment for CRPS. Is it right for me?

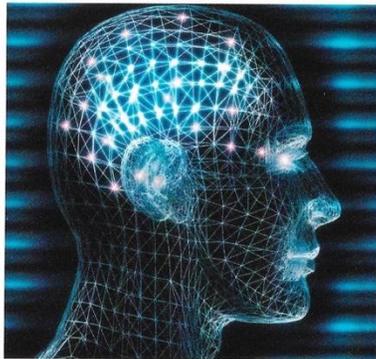


Mirror Box Therapy: How it works

Mirror therapy is like a work out for your brain.

Why is this needed?

Your own body is represented in your brain like a map. However, with a chronic pain syndrome like CRPS I, the part of this map that represents your ability to feel and move your painful limb may begin to change. The brain is changeable, and mirror therapy is a way of "tricking" your brain into exercising the pathways used by your painful limb.



Mirror Box Therapy: Research

Research has shown that mirror therapy can reduce pain, improve sensation, and improve function in patients with Chronic Regional Pain Syndrome (CRPS) type I. The research is in its infancy but results have been positive. Therefore, you should consult a hand therapist to develop an individualized mirror therapy program. The sooner you can begin mirror therapy after CRPS symptoms develop, the better.



Treatment Example: What your treatment might look like.

The most researched program for mirror therapy related to CRPS is called a "Graded Motor Imagery" program or GMI. It consists of:

Stage 1: "Limb laterality training"- before progressing to mirror therapy, it is important to make sure the brain can tell left from right. This left/right awareness can be impacted by chronic pain like that caused by CRPS.

Stage 2: "Imagined movements"- During this stage, you will think about moving without actually moving. This works out similar areas in the brain as you use when you actually move. It is important to back off if you feel pain.

And finally:

Stage 3: Mirror therapy- if you put your affected hand behind a mirror, you can trick your brain into believing the reflection in the mirror is your affected hand. Now you can exercise the part of your brain that moves your affected hand. Start with little to no movement and work up to greater pain-free movements.

For more information visit gradedmotorimagery.com

Pamphlet created by:
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Danielle L. Watson, OTS
with the University of Puget Sound Occupational Therapy Program

References:

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Please consult a certified hand therapist before using mirror therapy or any program like this. They can help you judge if mirror therapy is appropriate for you and where to begin. This program is a commitment and will work best if you do these exercises many times throughout the day.

Appendix D
Project Outcomes Survey

Has this project, or will this project, influence the way you practice in any way? If so, how?

Y N

How?

Did this evidence review improve your confidence in providing mirror therapy for patients w/
CRPS?

Y N

Did this project provide you with new information on this topic?

Y N

Do you foresee this pamphlet being helpful/educational for clients w/ this condition?

Y N

Do you feel the product created is appropriate for the audience for which it was designed?

Y N

Is there anything, in hindsight, you wish you had addressed?

Y N

Are you interested in participating in this project in the future?

Y N

Would you recommend this project to another clinician?

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