

There is strong evidence to support the use of mirror therapy to improve upper extremity motor recovery in patients with chronic CVA (greater than 6 months) compared with conventional therapy alone. The evidence does not support the use of mirror therapy to improve self-assessed ADL performance in this population.

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CLINICAL SCENARIO:

Condition/Problem:

A cerebral vascular accident (CVA), or a stroke, involves blockage of blood flow in the brain due to a clot or rupture in a surrounding blood vessel. A common residual problem of a CVA can be hemiparesis contralateral to the affected hemisphere. Depending on the location of the blockage in the brain, a variety of cognitive deficits may be seen. Deficits may include language expression and comprehension, memory, attention, orientation, and executive functioning.

Incidence/Prevalence:

According to the American Stroke Association, 795,000 people experience a CVA in the United States each year. About 80% of people who have had a stroke experience hemiparesis. Strokes are the leading cause of severe and long-term disability in the nation (American Stroke Association, 2014).

Impact of the Problem on Occupational Performance:

Hemiparesis post stroke can result in occupational performance deficits of motor control in ADLs and IADLs. Many dressing, feeding, hygiene, home management, meal preparation, and leisure activities require the use of the bilateral arms and hands to complete. Therefore, these activities may be difficult for individuals with hemiparesis. Decreased cognition may impact virtually all ADLs and IADLs, especially in the areas of hygiene, transfers, feeding, meal preparation, financial and home management. Psychosocial issues such as frustration, depression, and anger can arise when the client is unable or weary to participate in leisure and social activities due to impairments.

Intervention:

Mirror therapy intervention is used with clients post CVA to address impaired motor ability due to upper extremity hemiparesis. It is typically used as a preparatory method to better participate in occupations based activities. Mirror therapy consists of a mirror placed in the mid-sagittal plane between the affected arm and the unaffected arm. The client positions the unaffected arm in order to view the mirror image. The affected arm is occluded from vision. As the client views the mirror image of the unaffected arm, the brain perceives the affected arm as moving. The client performs bilateral and functional upper extremity movements, activating the impaired arm as much as possible throughout the movements.

Schedule and treatment context:

In the literature, mirror therapy is performed at least one time per day for 1 hour over approximately six weeks. This intervention can be applied in an outpatient, day treatment, or home setting.

Why is this intervention appropriate for OT?

This intervention is appropriate for occupational therapy as addressed in the Occupational Therapy Framework and Domain (3rd Ed.). Mirror therapy addresses body functions: muscle functions with

control of voluntary movement. It also addresses body structures: nervous system (American Occupational Therapy Association, 2008). Mirror therapy addresses the ICF levels of body function & structures.

Professional Use:

Mirror therapy may be utilized by OT, PT, and other trained rehabilitation professionals.

OT Theory:

The OT theory of motor learning supports the intervention of mirror therapy. From this theory, it is hypothesized that with plasticity, a brain can recover motor pathways by performing repetitive and isolated movements. The visual illusion in the mirror may provide motor pathway stimulation to the impaired arm through the mirror neuron system. Additionally, repetitive bilateral movements may provide the impaired arm with practice to recover motor pathways. Thus, motor recovery post stroke may be attained through repetitive practice of movement in the mirror (Krakauer, 2006).

Science Behind the Intervention:

Mirror therapy: Mirror therapy is theorized to facilitate cortical reorganization to the impaired primary motor cortex of the brain (Michielsen, Geest, Yayuzer, Smits, & Bussman, 2011). The theorized mechanism of change in this process is the mirror neuron system. As the client views the mirror, they are receiving a visual illusion of their impaired arm moving. This visual stimulation travels from the occipital lobe to the parietal lobe of the impaired hemisphere where the mirror neurons are housed (Kilner & Lemon, 2013). It is then hypothesized that the parietal lobe sends signals to the primary motor cortex, which stimulates movement of the impaired upper extremity. The mirror neurons are hypothesized to function similarly to motor neurons, resulting in muscle activation of the impaired upper extremity. Activation of these mirror neurons on the impaired hemisphere may facilitate reorganization of motor pathways. Due to neuroplasticity, repeated practice of movements may retain the pathway in the brain (Kilner & Lemon, 2013).

Bilateral exercises: Bilateral exercises are incorporated in this intervention. As the client views the mirror with the unaffected arm moving, the affected arm is simultaneously completing these movements to the best ability. As the image in the mirror is triggering stimulation of the mirror neurons in the affected hemisphere, the physical movement attempts to stimulate the motor neurons in the affected hemisphere directly. Essentially, the bilateral exercises are providing additional stimulation to the affected motor pathway.

Description of Biological Changes:

Mirror therapy intervention is theorized to make a change in the brain, which may affect motor recovery. A study completed by Michielsen, et al (2011) looked at the change in activation in fMRI brain images pre and post mirror therapy treatment compared to a control group. It was found that the primary motor cortex in the affected hemisphere showed more activation than the unaffected hemisphere in the mirror therapy group as compared to the control group. This study was completed with individuals with chronic stroke. This suggests that mirror therapy has the ability to provide cortical reorganization in the brain after the primary healing period has passed, due to the neuroplasticity of the brain using the mirror neuron system (Michielsen, et al., 2011).

FOCUSED CLINICAL QUESTION:

Does mirror therapy improve upper extremity motor recovery and ADL performance in patients with chronic CVA (greater than 6 months) more than conventional therapy alone?

- **Patient/Client Group:** Adults with chronic stroke (6 months or more) with UE hemiparesis
- **Intervention:** Mirror therapy (MT)
- **Comparison Intervention:** Conventional occupational therapy alone
- **Outcome(s):** Improved UE motor recovery and participation in ADLs

SUMMARY:

This CAT assesses whether mirror therapy improves upper extremity motor recovery and ADL performance in patients with chronic cerebral vascular accident more than conventional therapy alone. A total of eight databases were searched and three relevant articles were isolated using identified specific parameters. All three reviewed articles were level 1b individualized randomized control trials (RCT) with strong rigor. The total level of evidence of the appraised articles is grade A. This CAT determined mirror therapy may improve upper extremity motor recovery more than conventional therapy alone but does not have a significant effect on self-assessed ADL performance.

CLINICAL BOTTOM LINE:

There is strong evidence to support the use of mirror therapy to improve upper extremity motor recovery in patients with chronic CVA (greater than 6 months) compared with conventional therapy alone. The evidence does not support the use of mirror therapy to improve self-assessed ADL performance in this population.

Limitation of this CAT: This critically appraised paper (or topic) has been reviewed by occupational therapy graduate students and the course instructor.

SEARCH STRATEGY:

Table 1: Search Strategy

Databases Searched	Search Terms	Limits used	Inclusion and Exclusion Criteria
Strokingengine, CINAHL Full Text, Cochrane Database of Systematic Reviews, Medline Full Text, Psych-INFO, EbscoHost, Sage Journals, ScienceDirect	mirror therapy, chronic stroke. mirror therapy and stroke	Articles from 2004-2014	<p><i>Inclusion:</i> English only, full text only, Adults (18 years and older), at least 6 months post stroke, UE hemiparesis, impaired arm occluded from vision, instruction of bilateral movements during intervention, outcome measures of motor function and ADL performance.</p> <p><i>Exclusion:</i> Acute and subacute strokes (less than 6 months), impaired arm visible, Lower Extremity MT</p>

RESULTS OF SEARCH

Table 2: Summary of Study Designs of Articles Retrieved

Level	Study Design/ Methodology of Articles Retrieved	Total Number Located	Data Base Source	Citation
Level 1a	Systematic Reviews or Metanalysis of Randomized Control Trials	0		
Level 1b	Individualized Randomized Control Trials	3	Sage Journals, ScienceDirect	Michielsen, M., Geest, J., Yavuzer, G., Smits, M. & Bussmann, B. (2011) Lin, Huang, Chen, Wu, & Huang, (2014) Wu, Huang, Chen, Lin & Yang. (2013)
Level 2a	Systematic reviews of cohort studies	0		
Level 2b	Individualized cohort studies and low quality RCT's (PEDro < 6)	0		
Level 3a	Systematic review of case-control studies	0		
Level 3b	Case-control studies and non-randomized controlled trials	0		
Level 4	Case-series and poor quality cohort and case-control studies	0		
Level 5	Expert Opinion	0		

STUDIES INCLUDED

Table 3: Summary of Included Studies

	Study 1	Study 2	Study 3
Design	Randomized control trial	Randomized control trial	Randomized control trial
Level of Evidence	1b	1b	1b
PEDro score (only for RCT)	9	9	10
Population	40 chronic stroke patients, at least 1 year post stroke. Inclusion criteria included the ability to speak Dutch, having a Brunnstrom stage of recovery score of III to V, and living at home. Individuals who have had multiple strokes were excluded.	33 chronic stroke patients (onset more than 6 months) (19 ± 12.57 months since stroke) with mild-moderate motor impairment in UE. Inclusion criteria included first ever CVA, mild to moderate impairment (FMA= 26-56), mild spasticity in all joints of UE (MAS ≤ 2), and intact cognition (MMSE > 24). Participants with visual perceptual deficits, and severe psychological, neuromuscular, and orthopedic disorders were excluded.	43 chronic stroke patients, at least 6 months post stroke. 14 in MT group (10 M, 4 F) 15 in CT (11 M, 4 F). Inclusion criteria included stroke at least 6 months prior, Brunnstrom stage III or above in UE, Modified Ashworth Scale ≤ 2 , and intact cognition (MMSE > 24). Exclusion criteria were no serious vision or visual perceptual deficits, and no history of other chronic disabilities affecting movement.
Intervention Investigated	Both the mirror therapy group and control group participated in a six week program performing bimanual exercises with individualized difficulty based on the Brunnstrom stage level and functional activities. Mirror therapy group positioned the affected hand behind the mirror and the view of both hands was occluded. Participant viewed image of unaffected arm completing exercises and activities. Supervision	The intervention included 60 minutes of mirror therapy with the impaired arm occluded. The participants were then instructed in bilateral simultaneous movements including task such as fine motor manipulation, gross motor reaching, and AROM of the UE. This was followed up by 30 minutes of task-oriented training. Treatment duration was for 90 minutes a day, for 5	The intervention included 90 minute training sessions each day, five days a week for four weeks. A total treatment time of 30 hours was recorded. The session included 10 minutes of warm-up, 1 hour of mirror box training, and 20 minutes of functional task practice, dependent on the abilities of the participants. The warm-up activities included stretching and passive range of motion

	<p>occurred once a week at the clinic by a physical therapist and completed mirror therapy at home 1 hour per day, 5 times per week for 6 weeks for approximately 30 total hours of intervention. A diary of home practices and experiences was kept. Assessment completed at baseline, immediately post-treatment, and at 6-month follow-up.</p>	<p>days a week, over 4 weeks. Total treatment time included 30 hours of intervention.</p>	<p>exercises. The mirror training portion included motions such as supination and pronation. It also included motions of grabbing marbles, and placing cups on shelves, which the study identified as ADLs. Participants moved both hands simultaneously while watching the reflection of their unaffected UE (affected UE was occluded). The session ended in task-specific training. All other interdisciplinary stroke rehabilitation measures continued as normal.</p>
Comparison Intervention	<p>The comparison intervention included bimanual individualized exercises and functional activities while viewing both arms and without viewing a mirror image. The control group was supervised once a week by physical therapy and practiced at home 1 hour per day, 5 times per week for 6 weeks or approximately 30 total hours of treatment. The control group also kept diary of home practice and experiences. Assessment occurred at baseline, immediately post-treatment, and at a 6-month follow-up.</p>	<p>The comparison intervention included 90 minutes of task-based treatment specific to each client. Most treatments included focus on coordination, fine motor control, balance, and compensation in tasks (not otherwise detailed) 1.5 hours a day, 5 days a week, over 4 weeks. Total treatment time= 30 hours.</p>	<p>The comparison intervention included 90-minute training sessions per day, five days per week for four weeks for a total of 30 hours. All other interdisciplinary stroke rehab continued as normal. The treatment was based on task-oriented treatment principles. The tasks practiced were picked with consideration of the participants' abilities. The warm up exercises were similar to the other two groups (Mirror Therapy + Mesh Glove, and Mirror Therapy).</p>
Dependent Variables	<ol style="list-style-type: none"> 1. UE motor recovery 2. Use of UE in daily life 3. Cortical reorganization 4. Overall quality of life 	<ol style="list-style-type: none"> 1. UE motor recovery 2. Kinematics— maximum reaching distance and reaction time 3. Sensory impairment 4. ADL function 	<ol style="list-style-type: none"> 1. UE Motor recovery 2. Motor function 3. Daily function 4. Adverse effects 5. Kinematic data for motor control

Outcome Measures	<ol style="list-style-type: none"> 1. Fugl-Meyer Assessment (FMA)—body function 2. fMRI—body function 3. Grip strength—body function 4. Tardieu Scale for Spasticity—body function 5. Visual Analog Pain Scale—body function 6. Action Research Arm Test (ARAT)—activity 7. ABILHAND—activity 8. Stroke-ULAM—activity 9. EQ-5D quality of life assessment—participation 	<ol style="list-style-type: none"> 1. Fugl- Meyer Assessment (UE motor)—body function 2. VICON MX 7—camera motion analysis system—body function 3. Revised Nottingham Sensory Assessment—body function 4. ADL function—activity <ol style="list-style-type: none"> a. The Motor Activity Log—activity b. ABILHAND: self rated ADL performance—activity 	<ol style="list-style-type: none"> 1. Fugl- Meyer Assessment (UE motor)—body function 2. Myoton-3 device—body function 3. BBT—body function 4. 10-MWT—body function 5. The Motor Activity Log—activity 6. ABILHAND—activity 7. Kinematic data—body function 8. Adverse affects—body function
Results	<ol style="list-style-type: none"> 1. UE motor recovery: FMA showed statistically significant improvement of the mirror group ($p=.04$) at post treatment, no significant change at 6 month follow up ($p=.53$); No significant improvement in grip strength, spasticity, or pain. 2. Upper extremity use in daily life: ARAT, ABILHAND, Accelerometric proportion: No significant improvement in use of the affected hand in daily life. 3. Quality of life: EQ-5D: No significant improvement between groups. 4. fMRI: improvement was shown within the activation of primary 	<ol style="list-style-type: none"> 1. UE motor recovery: total FMA scores were significantly different between groups ($p=.009$). Within the FMA, the proximal UE section yielded no significant group differences ($p=.08$). The distal UE portion of the FMA yielded significant group differences ($p=.04$). 2. Kinematics: reaction time ($p=.04$), total displacement ($p=.04$), and shoulder-elbow cross-correlation ($p=.03$) all yielded significant group differences. No other significant changes were found in kinematics. 3. Sensory: There 	<ol style="list-style-type: none"> 1. UE motor recovery: FMA $p=.0031$ statistically significant; CT group improved more than the MT group in the BBT ($P = .007$ and $P = .036$, respectively); The CT group showed larger improvements than the MT group on the velocity of self-paced ambulation ($P = .031$), the stride of self-paced ambulation ($P = .016$), and the velocity of AQAP ($P = .023$). 2. No significant group effects were found on the ABILHAND or on the AOU and QOM of the MAL. 3. No adverse effects found 4. MT groups ($P = .023$) showed significantly greater reduction of

	motor cortex of the affected hemisphere in the mirror therapy group	were significant group differences in temperature sensation. No other sensory differences prevailed. 4. ADL performance: no significant differences were found between groups for self reported ADL performance.	maximum shoulder abduction than the CT; the CT group showed larger improvements than the MT group on normalized shoulder flexion ($P = .0013$).
Effect Size	FMA change score: post treatment was large effect size ($d=0.94$), and medium effect size at follow-up ($d=0.39$). ABILHAND change score: post treatment medium effect size ($d=0.3$), and small effect size ($d=0.034$) at follow-up.	FMA total change score was found to have a medium effect size ($d=.562$). Specifically, the proximal UE had a medium effect size ($d=.38$), and the distal UE had a very large effect size ($d=1.36$). ABILHAND change score was found to have a medium effect size ($d=.61$).	FMA total change score was found to be of large effect, $\eta^2= .15$ Specifically, the distal FMA was $\eta^2= .08$ while the proximal effect size was $\eta^2= .09$. The ABILHAND effect size of $\eta^2=.01$ was found to be a small size.
Conclusion	MT resulted in medium to large statistically significant improvements in upper extremity motor function as compared to the control group. These effects were maintained at a 6-month follow up after the intervention concluded. Mirror therapy did not result in improvements of ADL performance but did show cortical reorganization of the motor cortex of the affected hemisphere.	MT along with task based training resulted in significant and moderate to large effects for the return of UE motor control when compared to task based training alone. This intervention does not have a significant effect on self-reported ADL performance.	MT along with task specific training resulted in improved motor recovery and reduced the critical component of synergy patterns (i.e., shoulder abduction) more than conventional therapy alone. There was no significant group differences found for ADL performance.

IMPLICATIONS FOR PRACTICE, EDUCATION and FUTURE RESEARCH

Overall Conclusions:

Similarities:

- In all three studies, the MT intervention protocol included the impaired arm occluded from vision and simultaneous performance of bilateral exercise.
- Total treatment time was 30 hours.
- Same outcome measures used to examine motor recovery (Fugl-Meyer) and self-reported ADL performance (ABILHAND).
- Number of participants similar, ranging from 33 to 43.

Differences:

- Two studies (Wu et al., 2013, Lin et al., 2014), received MT and additional task specific training, performed in a clinical setting supervised and led by an OT. Task specific training involves practice of smaller task components through repetition to master the whole task (Sitcoff, Costa, & Korner-Bitensky, n.d.).
- In one study (Michielsen et al., 2011), the intervention was performed in the home environment, unsupervised, and with no concurrent interventions to the MT.
- Follow up scores for motor recovery were only reported in one study (Michielsen et al., 2011).
- The study by (Lin et al., 2013), used a third intervention group and combined MT with a mesh glove which provided electrical stimulation to the affected arm.

Motor Recovery Conclusions:

Motor recovery is defined as the return of volitional muscle function in the upper extremity. In all three appraised articles, motor recovery improved significantly more with MT intervention than conventional therapy alone. The evidence shows mirror therapy, either alone or combined with task specific training, can improve upper extremity motor recovery in patients with chronic stroke. An overall medium to large effect size on motor recovery was found between the three appraised articles. When combined with the treatment of a mesh glove utilizing an electrical stimulation device on the impaired arm, motor recovery improved greater than both the mirror therapy and control group (Lin et al., 2014). Motor recovery scores were maintained after a six-month follow up (Michielsen et al., 2011).

Self-reported ADL Performance Conclusions:

ADL performance involves activities that require bilateral upper extremity movements, such as dressing, bathing, and feeding. In all three studies, self reported ADL performance was not statistically significantly different from conventional therapy alone. There were small to medium effect sizes found in each study.

Boundaries:

The three articles appraised included 111 adult participants, ages 40-70 years. The inclusion criteria included chronic CVA of more than 6 months, adequate cognition to follow instructions, a Brunnstrom UE score between III and V, and a Modified Ashworth Scale (MAS) score of less than 2. Exclusion criteria included visual perceptual impairments, severe tone (MAS >2), and no comorbid diagnoses affecting movement. It is not advised to generalize these findings to anyone outside this specific population.

Implications for Clinical Practice:

Mirror therapy for 30 hours of treatment provided significant improvement to motor function in the upper extremity when compared to conventional therapy alone. These significant effects on motor

performance remained after 6 weeks at follow up (Michielsen et al., 2011). One study resulted with effects slightly above the Fugl-Meyer's minimal detectable change (MDC) of 5.2 (Wagner et al., 2008). However, none of the articles reached a level of detectable clinical change, suggesting the client would likely not notice an improvement within motor recovery as measured by the FMA. Participants showed improvements in motor recovery at least six months after the stroke occurred. Therefore, mirror therapy may be a useful treatment method after the primary healing time period has elapsed. In addition, mirror therapy may be a cost effective home program for individuals with chronic stroke. The studies did not report the specific movements or exercises utilized in each mirror therapy intervention. There were no significant findings in self-reported ADL performance, most likely because the exercises performed did not closely relate to ADL tasks. Future research should examine whether practicing actual ADL tasks in the mirror would have a generalizable effect to ADL performance.

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