Effects of Mirror Therapy to Improve Manual Dexterity in Paretic Hand after Stroke: A Quasi-experimental Study

ISSN: 2976-1077 (Online)

DoI: https://doi.org/10.58196/jswn.v9i31942024

Double Blinded

Peer Reviewed

Multi Disciplinary Journal

Web: https://jhswn.com/index.php/jhsw

Publishing Process

Received on: 2 March 2024

Finalized to publish after being peer reviewed on 15 April, 2024

Published on 23th April 2024

Effects of Mirror Therapy to Improve Manual Dexterity in Paretic Hand after Stroke: A Quasi-experimental Study

Sudip Auji[1], Esther Budha Magar[2], Krishti Gharti Magar[1], Surendra Kumar Meena[1]

Affiliations

[1]Mahatma Gandhi University of Medical Sciences and Technology, India

[2] Public Health Research Society Nepal, Nepal

Abstract:

Introduction: In lower-income and lower-middle-income nations, about a 70% increase in incident strokes has been observed followed by 43% deaths from stroke. The study aims to determine the effects of mirror therapy on manual dexterity in Stroke patients.

Methods: Quasi-experimental pre-post-test design was used in this study. The 10 participants with stroke with Brunnstrom stages 3 and 4 were assigned to either the experimental group or the control group. The current study investigated the effectiveness of using mirror therapy along with therapeutic exercises for improving the upper extremity motor performance in stroke patients.

Results: Intervention in which therapeutic exercises are incorporated along with mirror therapy proves to be an effective intervention strategy that can be used for improving the motor performance of the affected extremity in stroke patients p-value of 0.033 and 0.009 indicated that there is a significant difference between experimental and control group BBT and FMA scores respectively. Intervention in which therapeutic exercises were incorporated along with mirror therapy proved to be an effective intervention strategy that can be used for improving the motor performance of the affected extremity in stroke patients.

Conclusion: Both the intervention protocols are cost-effective, feasible and self-administered, thereby reducing the prolonged hospital stay for the patients and could be easily followed up at home for generalization. This study provides unique insight into the upper extremity capacity and performance during occupational therapy practice.

Keywords: Fine manual dexterity, Gross manual dexterity, Mirror therapy, Stroke

Declaration: There is no conflict of Interest.

*Corresponding author: Sudip Auji, Email: sudipinjesus@gmail.com

Effects of Mirror Therapy to Improve Manual Dexterity in Paretic Hand after Stroke: A Quasi-experimental Study

ISSN: 2976-1077 (Online)

DoI: https://doi.org/10.58196/jswn.v9i31942024

Double Blinded

Peer Reviewed

Multi Disciplinary Journal

Web: https://jhswn.com/index.php/jhsw

Publishing Process

Received on: 2 March 2024

Finalized to publish after being peer reviewed on 15 April, 2024

Published on 23th April 2024

Introduction:

Stroke is a cerebrovascular disorder featured by the sudden onset of clinical signs and symptoms of sensory, motor and cognition impairment. It is of two types where 80% of all cases are caused by Ischemic stroke remaining 20% by haemorrhagic stroke. Stroke is the third leading cause of disability and death combined. (Boursin, et.al., 2018). One of the major consequences of stroke is paretic upper limb increasing activity limitation and disability in the stork is manual dexterity impairment. Stork alters and changes the life of a whole family. About 85% of stroke survivors report experiencing hemiparesis and 55% to 75% of stroke survivors experience limitations in upper-extremity functioning. (Zhuang, et.al., 2021). Globally, in lower-income and lower-middle-income nations, about a 70% increase in incident strokes has been observed followed by 43% deaths from stroke. (Feigin, V. L.,et.al, 2022). The brain possesses a plasticity mechanism that has the potential for recovery. Research has found the prevalence of mirror neurons in a monkey's motor cortex is present particularly the ventral premotor cortex of the brain. Aftermath, various research erupted which targeted the functional aspects of mirror neurons leading to the revolution of neuro scientific world. Activation of mirror neurons occurs when action is observed and performed and this transforms the visual information stored in a particular area of the cortex for performing motor act. This functioning of the motor act is incorporated using mirror visual feedback therapy in neurorehabilitation. Further, where both simple and advanced activities are practiced and imitated. Earlier studies were conducted to understand the role of MNS in numerous functions including the imitation of actions, determining the goal-directed and meaningful action followed by advancement of motor skills and learnings. A novel thought has been contemplated stating the possibility of human beings' availability of particular mirror neurons to every individual part such as mouth, hand, and foot movements (Gandhi, D. B. et.al. 2020).

Mirror therapy (MT) is a rehabilitative methodology, which attracted a growing interest over the most recent couple of years. MT was initially used to alleviate phantom limb pain after upper limb removal. Since the strategy has been effectively applied to improve upper limb function in other neurological diseases and stroke populations. One of the significant reasons for the inability to Stroke is manual dexterity impairment leading to dependence on functional activities. Improving manual dexterity skills is given the utmost importance to enhance the functional performance of the upper limb in stroke patients. Hence, the above-mentioned evidence paved the way for the use of Mirror therapy in improving manual dexterity in stroke patients. The research study aims to determine the effect of Mirror therapy to improve manual dexterity in the paretic hand after a stroke. Specific objectives were to determine the pre-test and post-test scores of gross manual dexterity in the control group and experimental group and find the protest and post-test scores of fine manual dexterity in the control group and experimental group. The null hypothesis incorporates that there is no significant difference in manual dexterity in Stroke after Mirror Therapy whereas the alternate hypothesis states that there is a significant difference in manual dexterity in Stroke after Mirror Therapy.

Effects of Mirror Therapy to Improve Manual Dexterity in Paretic Hand after Stroke: A Quasi-experimental Study

ISSN: 2976-1077 (Online)

DoI: https://doi.org/10.58196/jswn.v9i31942024

Double Blinded

Peer Reviewed

Multi Disciplinary Journal

Web: https://jhswn.com/index.php/jhsw

Publishing Process

Received on: 2 March 2024

Finalized to publish after being peer reviewed on 15 April, 2024

Published on 23th April 2024

The null hypothesis incorporates that there is no significant difference in manual dexterity in Stroke after Mirror Therapy whereas the alternate hypothesis states that there is a significant difference in manual dexterity in Stroke after Mirror Therapy.

Materials and Methods.

Quasi-experimental pre-post study was conducted among 10 adults with sub-acute stroke. 5 participants were placed in the experimental group followed by 5 participants involved in the control group. Non-probability convenience sampling was used for the study. Participants with COVID-19 negative aged between 20 to 60 years diagnosed with stroke for the first time were taken as participants. Their FMA upper extremity scale lay between 10 and 57 (out of 66) and their MMSE score was above 24. Respondents with severe orthopaedic impairment in the upper limb, neurological conditions other than stroke and other visual field defects were not included in the study. Brunnstrom stages of motor recovery of hand, MMSE, and MAS were used for assessment. Outcome measures included box and block text, nine-hole peg test and Fugl Meyer hand component. Data was analysed using SPSS 22.0.

Brunnstrom Stage of Hand Recovery: The Brunnstrom stage of recovery demonstrates the sequence of motor development and relearning of the brain after stroke. Initial stages include flaccidity of the affected hand where little or no active finger flexion is observed followed by gradual mass grasp or hook grasp development where no voluntary finger extension or release is contemplated. Progress towards the semi-voluntary finger extension in a small range of motion is foreseen followed by lateral prehensile with release by thumb movement showcasing the palmar prehensile and prevalence of all types of prehensile.

Mini-Mental State Examination (MMSE): MMSE or Folstein test is a 30-point questionnaire. It is exclusively applied in clinical and research settings for measuring cognitive impairments. The components of this assessment tool include orientation, registration, attention and concentration, recall, language and copying.

Modified Ashworth Scale: The modified Acworth scale is a rating scale used to measure abnormality in muscle tone or resistance to passive movements. 0 indicates none of the increment in muscle tone. 1 depicted a slight increase in muscle tone, manifested by a catch or by minimal resistance throughout range of motion when the affected part was moved in flexion or extension. 1+ was linked with a slight increment in muscle tone, manifested by a catch or by minimal resistance throughout the remainder which is less than a half range of motion. 2 illustrated more marked in range of muscle tone through most of the range of motion (ROM), but affected part easily moved. 3 was applied for considerable increment in muscle tone and passive movement difficulty. 4 marked the affected part as being rigid in flexion or extension.

Box Block Test (BBT): The BBT is a simple and efficient test of gross manual dexterity majorly used by Occupational therapists in clinical settings.

Effects of Mirror Therapy to Improve Manual Dexterity in Paretic Hand after Stroke: A Quasi-experimental Study

ISSN: 2976-1077 (Online)

DoI: https://doi.org/10.58196/jswn.v9i31942024

Double Blinded

Peer Reviewed

Multi Disciplinary Journal

Web: https://jhswn.com/index.php/jhsw

Publishing Process

Received on: 2 March 2024

Finalized to publish after being peer reviewed on 15 April, 2024

Published on 23th April 2024

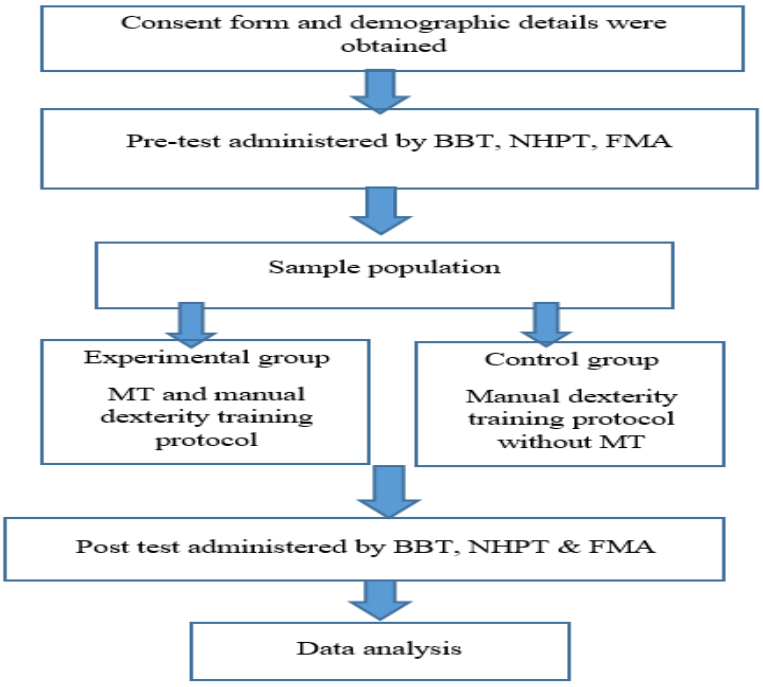
The BBT was administered by asking subjects to move, one by one, the maximum number of cubes measuring 1-inch square from one compartment of a box to another within 60 seconds. This research study tested both the dominant and non-dominant hands simultaneously.

Nine-Hole Peg Test: The hole peg test measures finger dexterity. The NHPT could be used with, but was not limited to clients with stroke. The amount of time taken to administer the NHPT has not been reported and it varied according to the client's impairment. Two studies have examined the validity and reported that NHPT was not able to predict functional outcomes. Three studies have examined the inter-rater reliability of the NHPT and reported excellent Pearson's correlation.

Fugl Meyer Assessment: FMA is a standardized assessment for post-stroke recovery. Predominantly, it assesses 4 major domains including sensation, joint pain, motor function and passive joint movement.

The motor score ranges from 0 (hemiplegia) to 100 points (normal motor performance) and 66 points for upper extremity. Sensation ranges from 0 to 24 points, joint range of motion from 0 to 44 points and joint pain from 0 to 44 points. An overall score of 36 to 55 indicated severe, 56 to 79 posited moderate and 79 meaning mild. Informed consent was obtained from all participants and the concerned institutions. Based on the screening criteria the patients were selected and divided into an experimental group (Manual dexterity training with MT) and a control group (Manual dexterity training without MT). In each patient, the designation of the "more affected side" was determined from the clinical history. After administering the baseline pre-test measures, both experimental and control groups undergo training for a total of 10 sessions (Bonassi, G et al., 2016) within 8 weeks. Post-test measures after 10 sessions were collected for data analysis.

Fig 1: Flow chart of the Experimental research study



Effects of Mirror Therapy to Improve Manual Dexterity in Paretic Hand after Stroke: A Quasi-experimental Study

ISSN: 2976-1077 (Online)

DoI: https://doi.org/10.58196/jswn.v9i31942024

Double Blinded

Peer Reviewed

Multi Disciplinary Journal

Web: https://jhswn.com/index.php/jhsw

Publishing Process

Received on: 2 March 2024

Finalized to publish after being peer reviewed on 15 April, 2024

Published on 23th April 2024

Intervention protocol

Mirror therapy: Outside of the mirror box, a sequential motor task was performed on the side which had less effect on stroke patients and inside the mirror box, the affected hand was placed. Simultaneously, all 5 participants carefully observed hand movements in the mirror which created the illusion of moving the more affected hand within stroke patients and non-affected hand in healthy controls, generating visual feedback training.

Manual Dexterity Training Protocol: The protocol included repetitive finger opposition movements where the opposition of the thumb to index, middle, ring, and little finger was performed (Bonassi, G et al., 2016) and 40 different-sized metal discs were turned as fast as possible within the spot (Christian P Kamm et al., 2015)

Therapeutic exercises: Initially, this exercise started with therapeutic clay being rolled between the wrists and the fingertips facing the palm surface on the table. Afterward, the same exercise of rolling the therapeutic clay was performed with the lateral part of the hand between the wrist and the fingertips. Then, the therapeutic clay was squeezed closing all the fingers tightly in one hand. Later, the therapeutic clay was flattened with the heel of the hand. Finally, the therapeutic clay was pinched between the thumbs and all the fingers then, the therapeutic clay was rolled into balls. The ethical approval was getting from the PG Departmental Research Committee (DRC), Mahatma Gandhi Occupational Therapy College, was taken for conducting this experimental study.

Result

The result incorporates two of the major findings entitled, primarily socio-demographic status followed by score measurement.

Socio-demographic status

Descriptive analysis such as frequencies and measures of tendency was used to describe the demographic data. The outcome measure scores within groups were analysed using a paired t-test and the comparison of outcome measures between the groups was analysed using an independent t-test.

Table 1: Demographic distribution of sub-acute stroke survivors

		Experimental Group		Control Group	
Characteristics		N	%	N	%
Age group	40 - 49 Years	2	40	1	20
	50 - 59 Years	3	60	4	80
Sex	Male	4	80	2	40
	Female	1	20	3	60
Side affected	Left	2	40	2	40
	Right	3	60	3	60
	Total	5	100	5	100

The demographic data shown in Table 1 illustrates most of the stroke survivors in the experimental group are within the age group 40- 49 years, and those in the control group is within the age group 50- 59 years. It also shows that the majority of the stroke survivors are males than females and are right-side affected rather than left-side affected.

Effects of Mirror Therapy to Improve Manual Dexterity in Paretic Hand after Stroke: A Quasi-experimental Study

ISSN: 2976-1077 (Online)

DoI: https://doi.org/10.58196/jswn.v9i31942024

Double Blinded

Peer Reviewed

Multi Disciplinary Journal

Web: https://jhswn.com/index.php/jhsw

Publishing Process

Received on: 2 March 2024

Finalized to publish after being peer reviewed on 15 April, 2024

Published on 23th April 2024

Control group

Table 2: Outcome measure scores within the control group

Test	N	Mean	Std. Dev.	Mini-mum	Maxi-mum	Z	P value
BBT _PRE	5	7.6	2.1	5.0	10.0	-1.633	0.1
BBT_POST	5	8.8	2.8	5.0	12.0		
NHPT_PRE	5	11.1	2.8	8.2	15.3	-1.604	0.1
NHPT_POST	5	9.9	2.3	7.3	12.4		
FMA_PRE	5	23.2	0.4	23.0	24.0	.000	1.0
FMA_POST	5	23.2	0.4	23.0	24.0		

Table 2 depicts the pre and post-test scores of BBT, NHPT and FMA within the control group of those who received just manual dexterity training programs without mirror therapy. It was observed that there were no changes in the control group. The p-values of 0.1, 0.1, and 1.0 indicate that there is no significant difference between Pre and post-test scores of BBT, NHPT and FMA respectively for the control group

Experimental group:

Table 3: Outcome measure scores within an experimental group

Test	N	Mean	Std. Dev.	Mini-mum	Maxi-mum	Z	P value
BBT _PRE	5	9.0	3.5	6.0	15.0	-2.060	0.039*
BBT_POST	5	14.0	3.7	10.0	20.0		
NHPT_PRE	5	10.0	4.5	3.1	15.4	-2.023	0.043*
NHPT_POST	5	7.1	3.6	1.4	11.3		
FMA_PRE	5	25.4	3.4	23.0	30.0	-2.032	0.042*
FMA_POST	5	28.2	5.0	24.0	35.0		

*Significant at 5% alpha level

The p-values of 0.039, 0.043 and 0.042 indicate that there is a significant difference between Pre and post-test scores of BBT, NHPT and FMA respectively for the experimental group.

Effects of Mirror Therapy to Improve Manual Dexterity in Paretic Hand after Stroke: A Quasi-experimental Study

ISSN: 2976-1077 (Online)

DoI: https://doi.org/10.58196/jswn.v9i31942024

Double Blinded

Peer Reviewed

Multi Disciplinary Journal

Web: https://jhswn.com/index.php/jhsw

Publishing Process

Received on: 2 March 2024

Finalized to publish after being peer reviewed on 15 April, 2024

Published on 23th April 2024

Table 4: Pre-test score comparison between an experimental group and control group

Test and Group		N	$\overline{X}$	Std. Dev.	P.tile 25	Median	P.tile 75	MWU	p-value
BBT_PRE	EXPG	5	9.0	3.5	7.0	8.0	9.0	10.5	0.673
	CG	5	7.6	2.1	6.0	8.0	9.0		
NHPT_PRE	EXPG	5	10.0	4.5	9.1	10.3	12.0	12.0	0.917
	CG	5	11.1	2.8	9.3	10.0	12.4		
FMA_PRE	EXPG	5	25.4	3.4	23.0	23.0	28.0	9.0	0.368
	CG	5	23.2	0.4	23.0	23.0	23.0		

EXPG= Experimental Group, CG= Control Group, P.tile= Percentile MWA= Man Whiteney U,

Results from table no. 4 depict the outcome measures and analysis between the experimental and control groups of those who received manual dexterity training programs with and without mirror therapy. The finding was individual performance in both tests of manual dexterity has shown marked differences.

Table No. 5: Post-test score comparison between experimental group and control group

Test and groups		N	$\overline{X}$	St.Dev	P.tile 25	Median	P.tile 75	MWU	p-value
BBT_POST	EXPG	5	4.0	3.7	12.0	4.0	14.0	2.5	0.033*
	CG	5	0.8	2.8	7.0	0.0	10.0		
NHPT_POST	EXPG	5	0.1	3.6	7.0	0.3	8.3	5.0	0.117
	CG	5	0.9	2.3	8.2	0.5	12.1		
FMA_POST	EXPG	5	8.2	5.0	25.0	5.0	32.0	0.5	0.009*
	CG	5	3.2	0.4	23.0	3.0	23.0		

*Significant at 5% alpha level; EXPG= Experimental Group, CG= Control Group, P.tile= Percentile MWU= Man Whiteney U,

The p-value of 0.033 indicates that there is a significant difference between experimental and control group BBT scores. Similarly, a p-value of 0.009 indicates that there is a significant difference between experimental and control group FMA scores. Wilcoxon signed rank was performed to find the significant difference between pre and post-test scores of BBT, NHPT and FMA.

Effects of Mirror Therapy to Improve Manual Dexterity in Paretic Hand after Stroke: A Quasi-experimental Study

ISSN: 2976-1077 (Online)

DoI: https://doi.org/10.58196/jswn.v9i31942024

Double Blinded

Peer Reviewed

Multi Disciplinary Journal

Web: https://jhswn.com/index.php/jhsw

Publishing Process

Received on: 2 March 2024

Finalized to publish after being peer reviewed on 15 April, 2024

Published on 23th April 2024

Discussion

The study illustrates the outcome measure analysis among the experimental group of those who received manual dexterity training programs with mirror therapy. These participants were instructed to observe the dexterity exercises by the unaffected hand which were reflected in the mirror. It was observed that marked changes were noted in all three outcome measures BBT, NHPT and FMA. This could be ascertained to the point that though with repeated instruction given to these participants, they were repeatedly watching the hand movement of the unaffected hand directly and then visually observing in the mirror. Hence the changes were observed in the affected hand.

Similarly, previous research has showcased and supported learning through relearning the action and imitation with regards to having a positive impact on motor activity training (Arya, et.al., 2015). It is a prominent action that with the support of mirror therapy applying a manual dexterity training program, movements of arms and hands were relatively improved. Accordingly, previous research studies clearly mentioned the relearning of the activities particular actions promoting motor training by the application of mirror therapy, and upper limb motor performance improvement. (Buccino, G, et al., 2004). The study results that there is a significant difference between pre and post-test scores of BBT, and FMA applying mirror therapy where p-values of 0.033 and 0.009 were obtained respectively similar to the findings of a study conducted in 2014 stating mean change scores possessing significantly greater values in the mirror therapy group than in the control group for FMA and the BBT with a p-value of 0.008 and 0.022 (Samuelkamaleshkumar, et.al., 2014). A significant association was observed in the FMA test similar to this research study finding (Michielsen, et.al., 2011).

Conclusion

Dexterity difficulties impede daily living task functioning in stroke. The current study investigated the effectiveness of using mirror therapy along with therapeutic exercises for improving the upper extremity motor performance in stroke patients. Intervention in which therapeutic exercises were incorporated along with mirror therapy proved to be an effective intervention strategy that can be used for improving the motor performance of the affected extremity in stroke patients. Both the intervention protocols are cost-effective, feasible and self-administered, thereby reducing the prolonged hospital stay for the patients and could be easily followed up at home for generalization. This study provides unique insight into the upper extremity capacity and performance during occupational therapy practice.

It also provides adequate evidence to incorporate newer intervention strategies such as mirror therapy and therapeutic exercises into occupational therapy practice with conventional therapies. As therapeutic is easily available and practiced at home it serves to be economical as it could be carried out even in the absence of family members safely. Since the usage of mirror boxes and therapeutic are feasible and effective, it can be used to improve the upper extremity performance in the stroke population, in a hospital setting as well as in a home setting.

Effects of Mirror Therapy to Improve Manual Dexterity in Paretic Hand after Stroke: A Quasi-experimental Study

ISSN: 2976-1077 (Online)

DoI: https://doi.org/10.58196/jswn.v9i31942024

Double Blinded

Peer Reviewed

Multi Disciplinary Journal

Web: https://jhswn.com/index.php/jhsw

Publishing Process

Received on: 2 March 2024

Finalized to publish after being peer reviewed on 15 April, 2024

Published on 23th April 2024

Reference

Arya, K. N., Pandian, S., Kumar, D., & Puri, V. (2015). *Task-Based Mirror Therapy Augmenting Motor Recovery in Poststroke Hemiparesis:* A Randomized Controlled Trial. Journal of stroke and cerebrovascular diseases : the official journal of National Stroke Association, 24(8), 1738–1748. https://doi.org/10.1016/j.jstrokecerebrovasdis.2015.03.026

Boursin, P., Paternotte, S., Dercy, B., Sabben, C., & Maïer, B. (2018). *Sémantique, épidémiologie et sémiologie des accidents vasculaires cérébraux* [Semantics, epidemiology and semiology of stroke]. Soins; la revue de reference infirmiere, 63(828), 24–27. https://doi.org/10.1016/j.soin.2018.06.008

Buccino G, Vogt S, Ritzl A, et al (2004). Neural circuits underlying imitation learning of hand actions: An event-related fMRI study. Neuron 42:323-334.

Bonassi, G., Pelosin, E., Ogliastro, C., Cerulli, C., Abbruzzese, G., & Avanzino, L. (2016). *Mirror Visual Feedback to Improve Bradykinesia in Parkinson's disease.* Neural plasticity, 2016, 8764238. doi:10.1155/2016/8764238

Feigin, V. L., Brainin, M., Norrving, B., Martins, S., Sacco, R. L., Hacke, W., Fisher, M., Pandian, J., & Lindsay, P. (2022). *World Stroke Organization (WSO): Global Stroke Fact Sheet 2022. International journal of stroke* : official journal of the International Stroke Society, 17(1), 18–29. https://doi.org/10.1177/17474930211065917

Gandhi, D. B., Sterba, A., Khatter, H., & Pandian, J. D. (2020). *Mirror Therapy in Stroke Rehabilitation: Current Perspectives. Therapeutics and clinical risk management*, 16, 75–85. https://doi.org/10.2147/TCRM.S206883

Kamm, C. P., Mattle, H. P., Müri, R. M., Heldner, M. R., Blatter, V., Bartlome, S., Lüthy, J., Imboden, D., Pedrazzini, G., Bohlhalter, S., Hilfiker, R., & Vanbellingen, T. (2015). *Home-based training to improve manual dexterity in patients with multiple sclerosis: A randomized controlled trial. Multiple sclerosis* (Houndmills, Basingstoke, England), 21(12), 1546–1556. https://doi.org/10.1177/1352458514565959

Michielsen, M. E., Selles, R. W., van der Geest, J. N., Eckhardt, M., Yavuzer, G., Stam, H. J., Smits, M., Ribbers, G. M., & Bussmann, J. B. (2011). *Motor recovery and cortical reorganization after mirror therapy in chronic stroke patients: a phase II randomized controlled* trial. Neurorehabilitation and neural repair, 25(3), 223–233. https://doi.org/10.1177/1545968310385127

Samuelkamaleshkumar, S., Reethajanetsureka, S., Pauljebaraj, P., Benshamir, B., Padankatti, S. M., & David, J. A. (2014). *Mirror therapy enhances motor performance in the paretic upper limb after stroke: a pilot randomized controlled trial.* Archives of physical medicine and rehabilitation, 95(11), 2000–2005. https://doi.org/10.1016/j.apmr.2014.06.020

Zhuang, J. Y., Ding, L., Shu, B. B., Chen, D., & Jia, J. (2021). *Associated Mirror Therapy Enhances Motor Recovery of the Upper Extremity and Daily Function after Stroke: A Randomized Control Study.* Neural plasticity, 2021, 7266263. https://doi.org/10.1155/2021/7266263