Interdisciplinary Practice in Industrial Design, Vol. 48, 2022, 73–82
https://doi.org/10.54941/ahfe1002018

Enhancing Patient Engagement: The Development of Mirror Therapy Tasks for Stroke Rehabilitation

Yu-Hsiu Hung[1], Yu-Ching Lin[2,3], Shan-Song Yang[1], and Yen-Chen Liu[4]

[1]Department of Industrial Design, National Cheng Kung University, Tainan, Taiwan
[2]Department of Physical Medicine and Rehabilitation, College of Medicine, National Cheng Kung University, Tainan, Taiwan
[3]Department of Physical Medicine and Rehabilitation, National Cheng Kung University Hospital, Tainan, Taiwan
[4]Department of Mechanical Engineering, National Cheng Kung University, Tainan, Taiwan

ABSTRACT

Background: Mirror therapy (MT) has been shown to improve upper extremity function in stroke rehabilitation. In MT, engaging patients in meaningful therapeutic exercise determines patients' motivations and further the effectiveness of a rehabilitation program. The purpose of this study was to explore tasks that effectively enhance patient engagement in MT. Five participants with clinical and industrial design background were recruited to perform brainstorming activities for generating MT task ideas. All task ideas were evaluated by two rehabilitation specialists on the applicability based on the current MT protocol. Four task ideas (out of 74) were chosen by the two specialists and design recommendations were made for improving their feasibilities in MT. These ideas were: filling the blank with stamping tools (on magnetic board), spelling words with wooden letter dice, making patterns with black/white cubes, and making 3D shapes with clay. After identifying the potential task ideas, fifteen participants were recruited to assess the four developed MT tasks as well as five most-mentioned MT tasks in the literature using the User Engagement Scale (Short Form). One-way repeated measures ANOVA and pairwise comparisons were then conducted on participants' rating scores. Results showed that participants' rating scores for "filling the blank with stamping tools (on magnetic board)" as well as "making 3D shapes with clay" were significantly higher than those of five conventional MT tasks. The outcomes of the study benefit the communities of occupational therapy in the design of MT tasks.

Keywords: Mirror therapy, User engagement, Stroke rehabilitation

INTRODUCTION

Stroke is one of the leading causes of disability (Warlow et al., 2011). About 60% of stroke survivors experienced hemiparesis, which is the affection of face, upper extremity, or lower extremity movements (O'Dell, Lin, & Harrison, 2009). The limitations of upper extremity function were the most common symptom, and more than 50% of stroke survivors still have not

fully recovered upper extremity motor function after four years (Lawrence et al., 2001; Pollock et al., 2014). Many interventions and techniques were developed to improve the upper extremity function, such as repetitive task training, constraint induced movement therapy (CIMT), mirror therapy (MT), electrical stimulation, and transcranial magnetic stimulation (TMS) (Pollock et al., 2014). MT is less expensive and requires less therapist involvement compared with other therapy, which makes it possible to use it at home. Other treatments, such as repetitive task training and TMS, are more expensive, labor-intensive, and require lots of interaction with the therapist, making them unavailable for large-scale use. Therefore, mirror therapy is recommended as a suitable alternative therapy in stroke rehabilitation (Nogueira et al., 2021; Wu, Huang, Chen, Lin, & Yang, 2013).

MT uses the mirror reflection of the unaffected side to stimulate the brain. Patients cover the affected side with a mirror and watch the movements of the unaffected side in the mirror while imaging the reflection is their affected extremity before stroke (Deconinck et al., 2015; Nogueira et al., 2021). Several theories have been proposed to investigate MT. One of the theories suggests that paralysis after stroke is caused by learned non-use of the affected side, and MT helps patients forget what they learned. Another theory suggests mirror illusion activated the mirror neuron system to induce cortical reorganization in the affected side of the brain (Nogueira et al., 2021). Studies have found that MT improves upper and lower extremity function, enhances activities of daily living, increases sensory recovery in stroke patients (Arya, Pandian, Kumar, & Puri, 2015; Deconinck et al., 2015). There are two types of tasks in MT: movement-based MT(MMT) and task-based MT(TMT). MMT uses hand to do simple movements, including finger extension/flexion, wrist ulnar/radial deviation. TMT uses hand and objects for goal-oriented tasks, such as: stacking blocks, wiping table with towel. (Bei, Zhang, Zhang, Shu, & Niu, 2019). Research on the effects of MMT and TMT on upper extremity rehabilitation are still inconclusive, but task-based actions seem to be more effective than simple movements. This may be due to the greater response of mirror neurons to object-directed actions than non-object actions associated with mirror therapy (Arya et al., 2015; Bei et al., 2019; Yoo et al., 2013).

Although MT has positive effects on function recovery, patients often complain feeling bored and have low engagement during treatment (Horne et al., 2015; Lee, Cho, & Song, 2012). Engagement, which reduces reluctance in rehabilitation, has been suggested to be one of the influencing factors in long-term rehabilitation of stroke patients (Yao et al., 2017). Studies found lower engagement is related to poorer rehabilitation effectiveness. Conversely, patients' higher engagement promotes therapeutic effects, such as cortical plasticity and recovery of extremity functions (Horton, Howell, Humby, & Ross, 2011; Li, Rusak, Horvath, & Ji, 2016; Williams, Rapport, Hanks, & Parker, 2021). Numerous studies have attempted to increase engagement to avoid patient boredom with repetitive movement in stroke rehabilitation (Li, Rusak, Horvath, Kooijman, & Ji, 2017). For example, Charles, Holmes, Charles, and McDonough (2020) suggest that applying VR in rehabilitation can provide high-intensity and meaningful repetitive

exercises. It can prevent patients from feeling bored and reduce nonparticipation in upper extremity training. Randriambelonoro et al. (2020) found that patients considered serious games combined with lower extremity rehabilitation to be fun, improve confidence, and have positive impact on extremity function similar to conventional training. Segal, Lesak, Silverman, and Petruska (2020) demonstrated that using the Gesture-Controlled Rehabilitation Robot increased patient engagement, and the number of wrist motion repetitions per minute was twice as high as the number in functional task training.

Studies found that higher engagement enables better therapeutic outcomes, thus improving extremity function and prevented nonparticipation among the patients. However, the ways to improve patient engagement in MT has not been well studied. (Wu et al., 2013; Kim, Lee, Kim, Lee, & Kim, 2016). The aim of this study was to investigate potential tasks that were able to enhance engagement in TMT. The major contribution of this study is that it inspires occupational therapists in developing effective MT tasks and exercises. In addition, the outcomes of this study also benefit stroke patients in reducing boredom during MT.

METHOD

Participants

Purposeful sampling was employed to recruit participants. The sampling criterion was that participants had to have clinical research experiences. To this end, five participants (three females and two males, aged 21-26) with clinical and/or industrial design background participated in this study and performed brainstorming activities to generate task ideas for MT.

The task ideas were evaluated by two rehabilitation specialists (with real world experiences interacting with stroke patients) on their applicability in current MT protocol. After the tasks were selected and modified to satisfy the therapeutic requirements of MT, fifteen participants (seven females and eight males, aged 21-29) were recruited and used the User Engagement Scale - Short Form (UES-SF) to assess four developed MT and five conventional tasks. The conventional tasks were the most mentioned TMT tasks addressed in Nogueira et al. (2021). They were: (1) plugging and unplugging pegboards; (2) turning/grasping/moving blocks; (3) grasping/releasing a soft ball; (4) flipping cards, and (5) drinking/pouring water with a cup.

Procedure

Phase A: This study started with brainstorming to generate MT task ideas. Brainstorming is one of the most widely used methods (Daly, Seifert, Yilmaz, & Gonzalez, 2016; Putman & Paulus, 2009) to generate a large number of ideas. Our recruited participants were instructed with the purposes of this study, MT, and patients' complaints of MT tasks/exercises. Participants were then encouraged to generate wild ideas that had potentials to enhance patient engagement. The aim of this phase is quantity rather than quality.

The requirements for the task and exercise employed in MT were provided to the participants and were shown as follows: a) the patients must do the task alone; b) the task must be done with one hand; c) patients do not get bored easily. After the instructions, participants performed brainstorm activities for 50 minutes according to their provided MT tasks. In this study, five conventional MT tasks were evenly distributed to every participant as the starting point for brainstorming task ideas. Every participant had to generate three ideas in 10 minutes after seeing the provided MT task. After finishing the work, every participant had to pass his/her three ideas to the next participant. The next participant then had to generate three ideas based on the idea he/she saw. Our study went through five rounds of the pass-along brainstorming activities.

Phase B: In this session, all task ideas were assessed by two rehabilitation specialists (with real world experiences interacting with stroke patients) on the applicability based on the current MT protocol. The assessment criteria followed the ones suggested by Lohse et al. (2013) and Timmermans, Spooren, Kingma, and Seelen (2010). The purpose was to screen out the tasks that had low possibilities of engaging patients in MT. The screening criteria were as follows: (1) requiring both hands to complete the task in front of the mirror; (2) easy to feel bored in long-term use; (3) tasks involving a higher level of repeated movements; (4) tasks requiring the assistance of another person; (5) the range of hand movements in the task exceeding the size of the mirror; (6) tasks not achieving any functional goal or enhancing patients' physical capabilities (e.g., grasping or holding objects); (7) high risks in performing the task; (8) physical movements in the task not related with daily life; (9) tools/equipment used for the task made with uncommon materials; (10) using a bigger number of/complicated tools/equipment for completing the task; (11) tasks requiring patients paying more attention on physical tools/equipment rather than those in the mirror; (12) tasks demanding higher physical efforts from the patients.

After screening out infeasible task ideas, two rehabilitation specialists made design recommendations on the remaining task ideas to improve their applicability.

Phase C: In this session, the UES-SF was used to assess the level of patient engagement on the nine MT tasks, including the refined tasks and five conventional MT tasks. The question items used for the assessment are: (1) The time I spent in performing the task just slipped away; (2) I felt frustrated while performing the task in mirror therapy; (3) Performing the task in mirror therapy was worthwhile; (4) I lost myself in performing the task; (5) Performing the task was taxing; (6) I felt interested in performing the task; (7) Performing the task in mirror therapy was rewarding; (8) I found performing the task confusing to use in mirror therapy; (9) I feel absorbed in performing the task.

Participants were recruited through the social network of the researchers in this study. The assessment was done individually on the laptop. The time to complete the assessment was not restricted. All participants were encouraged to ask any questions during the assessment.

UES-SF has been demonstrated good reliability and validity (O'Brien, Cairns, & Hall, 2018). UES-SF has twelve question items, each with five response categories (from one to five, strongly disagree to strongly agree). The questions address the following constructs: aesthetic appeal, focused attention, perceived usability, and reward. In this study, questions related with aesthetic appeal were not included as most MT boxes look very similar.

RESULTS AND DISCUSSION

Seventy-four task ideas were generated from the brainstorming activities (one participant generating only two tasks ideas in the last round). Four task ideas were chosen by the rehabilitation specialists that best satisfied the requirements of MT and our idea screening criteria. The four MT tasks were modified based on the recommendations of the specialists. The tasks and the descriptions are shown in Table 1.

Table 2 shows the means and the standard deviations of the rating scores by fifteen participants on the four developed MT tasks as well as five conventional MT tasks. From Table 2, in general, all MT tasks developed from this study performed better in user engagement (the lowest mean rating score >3.5) than the conventional tasks (all mean rating scores between 3 and 3.5). Results of one-way repeated measures ANOVA indicated that there are significant differences among the nine tasks on the level of patient engagement ($F_{(8, 128)}=14.439$, $p<0.001$). Results of the pairwise comparisons (with the Bonferroni adjustment) on the mean ratings of user engagement are also shown in Table 2. The mean differences that had statistical significance were marked with asterisk(s).

In addition, from Table 2, participants' mean rating score for "filling the blank with stamping tools (on magnetic board)" was significantly higher than those of "plugging/unplugging pegboards" ($p<0.001$), "turning/grasping/moving blocks" ($p<0.001$), "grasping/releasing a soft ball" ($p<0.001$), "flipping cards" ($p<0.001$), and "drinking/pouring water with a cup" ($p<0.001$). Similarly, participants' mean rating score for "creating 3D shapes with clay" was significantly higher than those of "plugging/unplugging pegboards" ($p<0.001$), "turning/grasping/moving blocks" ($p<0.001$), "grasping/releasing a soft ball" ($p<0.001$), "flipping cards" ($p<0.001$), and "drinking/pouring water with a cup" ($p<0.001$). Furthermore, participants' mean rating score for "spelling words with wooden letter dice" was significantly higher than that of "flipping cards" ($p<0.05$).

In this study, our developed task "making patterns with black/white cubes" did not significantly receive higher ratings than those of the conventional tasks. One possible reason (from the feedback of some participants after the assessment) was that the task required higher mental workload, making the participants feeling tired easily. Regarding another MT task developed from this study, i.e., "spelling words with wooden letter dice," its rating scores among the participants did not seem to be significantly superior than those of most other tasks. The mean rating was only significantly higher than that of "flipping cards." One possible reason was that spelling words requires English literacy, thus reducing patients' engagement.

Table 1. The developed MT tasks and task descriptions from this study.

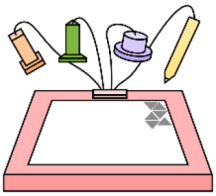
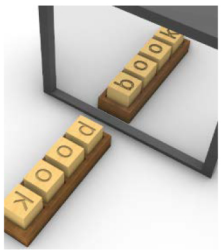
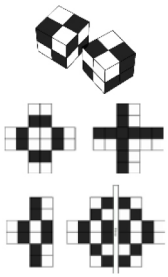
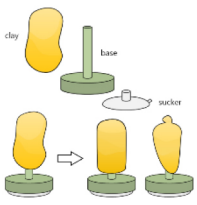
Task	Description	Picture
Filling the blank with stamping tools (on magnetic board)	**Equipment:** A magnetic drawing board with a pen and stamps with different shapes. The pen and the stamps are attached to the board with wires to avoid loss. **Instructions:** Use a pen/stamp to fill the white blank area. In each day, select a different tool. During the task, look at the mirror (rather than looking at the board) to complete the task. Make each stamp as close as possible without overlapping.	
Spelling words with wooden letter dice	**Equipment:** (1) Four wooden dice/cubes (each side showing the reflection of a letter in the mirror). For example, if an user wants to see letter b in the mirror, the top side of a cube has to have letter "d"; (2) A rectangular cube holder allows users to make words from letters. The holder can be used to store the dice/cubes in the environment; (3) A mobile application or a booklet containing pages of fun stories with pictures. **Instructions:** Look into the mirror and roll the dice to make the words, sentences, and stories shown on the booklet/mobile application. Complete one story per day.	
Making patterns with black/white cubes	**Equipment:** (1) Five dice with black/white squares on each side; (2) A mobile application or a booklet containing pages of differing image patterns formed by five dice. **Instructions:** Look into the mirror. Roll the dice to make the image patterns shown on the mobile application/booklet in each day. The image patterns to be made are different from Monday to Sunday.	
Creating 3D shapes with clay	**Equipment:** A stick bar holding clay ()(2) A mobile application or a booklet containing pages of differing 3D shapes. **Instructions:** Look into the mirror. Use the clay on the bar to make 3D shapes according to the image shown on the mobile application or booklet daily.	

Table 2. Descriptive statistics and pairwise comparisons on the subjective ratings of user engagement (from one to five) on nine MT tasks.

Mirror Therapy tasks: Mean (SD)		Filling the blank with stamping tools	Spelling words with wooden letter dice	Making patterns with black/ white cubes	Creating 3D shapes with clay	*Plugging/ unplugging pegboards*	*Turning/ grasping/ moving blocks*	*Grasping/ releasing a soft ball*	*Flipping cards*	*Drinking/ pouring water with a cup*
	3.95 (0.34)	3.63 (0.41)	3.63 (0.46)	4.01 (0.33)	3.29 (0.52)	3.37 (0.29)	3.33 (0.50)	3.07 (0.31)	3.13 (0.32)	
Filling the blank with stamping tools	3.95 (0.34)	0	0.31	0.31	−0.07	**0.66*** **	**0.58*** **	**0.61*** **	**0.88*** **	**0.82*** **
Spelling words with wooden letter dice	3.63 (0.41)	−0.31	0	−0.00	−0.38	0.35	0.26	0.30	**0.57***	0.50
Making patterns with black/ white cubes	3.63 (0.46)	−0.31	0.00	0	−0.38	0.35	0.26	0.30	0.57	0.50
Creating 3D shapes with clay	4.01 (0.33)	0.07	0.38	0.38	0	**0.73****	**0.64*** **	**0.68*** **	**0.95*** **	**0.88*** **
Plugging/ unplugging pegboards	3.29 (0.52)	**−0.66*** **	−0.35	−0.35	**−0.73****	0	−0.09	−0.05	0.22	0.16
Turning/ grasping/ moving blocks	3.37 (0.29)	**−0.58*** **	0.26	−0.26	**−0.64*** **	0.09	0	0.04	0.31	0.24
Grasping/ releasing a soft ball	3.33 (0.50)	**−0.61*** **	−0.30	−0.30	**−0.68*** **	0.05	−0.04	0	0.27	0.20
Flipping cards	3.07 (0.31)	**−0.88*** **	**−0.57***	−0.57	**−0.95*** **	−0.22	−0.31	−0.27	0	−0.07
Drinking/ pouring water with a cup	3.13 (0.31)	**−0.82*** **	−0.50	−0.50	**−0.88*** **	−0.16	−0.242	−0.20	0.07	0

Note: (1) Our developed tasks are marked in bold; the conventional tasks are italicized. (2) The number in each cell represents the difference between the mean rating of its corresponding row and that of its corresponding column. (3) * means $p < .05$, ** means $p < .01$, *** means $p < 0.001$.

There are two limitations in this study. One was that we only looked at the variable "engagement." The actual rehabilitation effects of our developed tasks require further investigations. The other limitation was that the ratings on patient engagement were based on participants' subjective conjectures. Feedback from real stroke patients are expected in future studies.

CONCLUSION

The purpose of this study was to develop tasks and exercises for MT that enhanced patient engagement. Brainstorming activities were performed that generated a total of 74 task ideas. The task ideas were screened by two rehabilitation specialists. The remaining four ideas were further modified to satisfy the therapeutic requirements of the current MT protocol. The developed MT tasks were then assessed by 15 participants who have experiences on clinical research in respect to patient engagement using the UES-SF. The outcomes suggested that "filling the blank with stamping tools (on magnetic board)" as well as "making 3D shapes with clay" were superior than the conventional MT tasks in engaging patients in MT and had the potential to be adopted in current stroke rehabilitation. Results of this study seemed to reveal that TMT performed better than conventional MMT in engaging patients in their rehabilitation. Such outcomes deserve further investigations and clinical evidence for verifications.

REFERENCES

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 & Cerebrovascular Diseases, 24(8), 1738–1748. doi:10.1016/j.jstrokecerebrovasdis.2015.03.026

Bei, Z. F., Zhang, J. Q., Zhang, Z. W., Shu, T., & Niu, W. X. (2019). Comparison Between Movement-Based and Task-Based Mirror Therapies on Improving Upper Limb Functions in Patients With Stroke: A Pilot Randomized Controlled Trial. Frontiers in Neurology, 10. doi:10.3389/fneur.2019.00288

Charles, D., Holmes, D., Charles, T., & McDonough, S. (2020). Virtual Reality Design for Stroke Rehabilitation. In P. M. Rea (Ed.), Biomedical Visualisation, Vol 6 (Vol. 1235, pp. 53–87). Cham: Springer International Publishing Ag.

Daly, S. R., Seifert, C. M., Yilmaz, S., & Gonzalez, R. (2016). Comparing Ideation Techniques for Beginning Designers. Journal of Mechanical Design, 138(10), 12. doi:10.1115/1.4034087

Deconinck, F. J. A., Smorenburg, A. R. P., Benham, A., Ledebt, A., Feltham, M. G., & Savelsbergh, G. J. P. (2015). Reflections on Mirror Therapy: A Systematic Review of the Effect of Mirror Visual Feedback on the Brain. Neurorehabilitation and Neural Repair, 29(4), 349–361. doi:10.1177/1545968314546134

Horne, M., Thomas, N., McCabe, C., Selles, R., Vail, A., Tyrrell, P., & Tyson, S. (2015). Patient-directed therapy during in-patient stroke rehabilitation: stroke survivors' views of feasibility and acceptability. Disability and Rehabilitation, 37(25), 2344–2349. doi:10.3109/09638288.2015.1024341

Horton, S., Howell, A., Humby, K., & Ross, A. (2011). Engagement and learning: an exploratory study of situated practice in multi-disciplinary stroke rehabilitation. Disability and Rehabilitation, 33(3), 270–279. doi:10.3109/09638288.2010.524270

Kim, K., Lee, S., Kim, D., Lee, K., & Kim, Y. (2016). Effects of mirror therapy combined with motor tasks on upper extremity function and activities daily living of stroke patients. Journal of Physical Therapy Science, 28(2), 483–487.

Lawrence, E. S., Coshall, C., Dundas, R., Stewart, J., Rudd, A. G., Howard, R., & Wolfe, C. D. A. (2001). Estimates of the prevalence of acute stroke impairments and disability in a multiethnic population. Stroke, 32(6), 1279–1284. doi:10.1161/01.Str.32.6.1279

Lee, M. M., Cho, H. Y., & Song, C. H. (2012). The Mirror Therapy Program Enhances Upper-Limb Motor Recovery and Motor Function in Acute Stroke Patients. American Journal of Physical Medicine & Rehabilitation, 91(8), 689–696. doi:10.1097/PHM.0b013e31824fa86d

Li, C., Rusak, Z., Horvath, I., & Ji, L. H. (2016). Development of engagement evaluation method and learning mechanism in an engagement enhancing rehabilitation system. Engineering Applications of Artificial Intelligence, 51, 182–190. doi:10.1016/j.engappai.2016.01.021

Li, C., Rusak, Z., Horvath, I., Kooijman, A., & Ji, L. H. (2017). Implementation and Validation of Engagement Monitoring in an Engagement Enhancing Rehabilitation System. Ieee Transactions on Neural Systems and Rehabilitation Engineering, 25(6), 726–738. doi:10.1109/tnsre.2016.2591183

Lohse, K., Shirzad, N., Verster, A., Hodges, N., & Van der Loos, H. F. M. (2013). Video Games and Rehabilitation: Using Design Principles to Enhance Engagement in Physical Therapy. Journal of Neurologic Physical Therapy, 37(4), 166–175. doi:10.1097/npt.0000000000000017

Medley, A. R., & Powell, T. (2010). Motivational Interviewing to promote self-awareness and engagement in rehabilitation following acquired brain injury: A conceptual review. Neuropsychological Rehabilitation, 20(4), 481–508. doi:10.1080/09602010903529610

Nogueira, N., Parma, J. O., Leao, S., Sales, I. D., Macedo, L. C., Galvao, A., . . . Ferreira, B. D. (2021). Mirror therapy in upper limb motor recovery and activities of daily living, and its neural correlates in stroke individuals: A systematic review and meta-analysis. Brain Research Bulletin, 177, 217–238. doi:10.1016/j.brainresbull.2021.10.003

O'Brien, H. L., Cairns, P., & Hall, M. (2018). A practical approach to measuring user engagement with the refined user engagement scale (UES) and new UES short form. International Journal of Human-Computer Studies, 112, 28–39. doi:10.1016/j.ijhcs.2018.01.004

O'Dell, M. W., Lin, C. C. D., & Harrison, V. (2009). Stroke Rehabilitation: Strategies to Enhance Motor Recovery. Annual Review of Medicine, 60, 55–68. doi:10.1146/annurev.med.60.042707.104248

Pollock, A., Farmer, S. E., Brady, M. C., Langhorne, P., Mead, G. E., Mehrholz, J., & van Wijck, F. (2014). Interventions for improving upper limb function after stroke. Cochrane Database of Systematic Reviews(11), 171. doi:10.1002/14651858.CD010820.pub2

Putman, V. L., & Paulus, P. B. (2009). Brainstorming, Brainstorming Rules and Decision Making. Journal of Creative Behavior, 43(1), 23–39. Retrieved from <Go to ISI>://WOS:000278023100002

Randriambelonoro, M., Perrin, C., Blocquet, A., Kozak, D., Fernandez, J. T., Marfaing, T., . . . Graf, C. (2020). Hospital-to-Home Transition for Older Patients: Using Serious Games to Improve the Motivation for Rehabilitation - a Qualitative Study. Journal of Population Ageing, 13(2), 187–205. doi:10.1007/s12062-020-09274-7

Segal, A. D., Lesak, M. C., Silverman, A. K., & Petruska, A. J. (2020). A Gesture-Controlled Rehabilitation Robot to Improve Engagement and Quantify Movement Performance. Sensors, 20(15), 18. doi:10.3390/s20154269

Timmermans, A. A. A., Spooren, A. I. F., Kingma, H., & Seelen, H. A. M. (2010). Influence of Task-Oriented Training Content on Skilled Arm-Hand Performance in Stroke: A Systematic Review. Neurorehabilitation and Neural Repair, 24(9), 858–870. doi:10.1177/1545968310368963

Warlow, C. P., Van Gijn, J., Dennis, M. S., Wardlaw, J. M., Bamford, J. M., Hankey, G. J., . . . Sudlow, C. (2011). Stroke: practical management: John Wiley & Sons.

Williams, M. W., Rapport, L. J., Hanks, R. A., & Parker, H. A. (2021). Engagement in rehabilitation therapy and functional outcomes among individuals with acquired brain injuries. Disability and Rehabilitation, 43(1), 33–41. doi:10.1080/09638288.2019.1613682

Wu, C. Y., Huang, P. C., Chen, Y. T., Lin, K. C., & Yang, H. W. (2013). Effects of Mirror Therapy on Motor and Sensory Recovery in Chronic Stroke: A Randomized Controlled Trial. Archives of Physical Medicine and Rehabilitation, 94(6), 1023–1030. doi:10.1016/j.apmr.2013.02.007

Yao, M. Q., Chen, J. H., Jing, J. Y., Sheng, H., Tan, X., & Jin, J. F. (2017). Defining the rehabilitation adherence curve and adherence phases of stroke patients: an observational study. Patient Preference and Adherence, 11, 1435–1441. doi:10.2147/ppa.S139854

Yoo, I. G., Jung, M. Y., Yoo, E. Y., Park, S. H., Park, J. H., Lee, J., & Kim, H. S. (2013). Effect of specialized task training of each hemisphere on interlimb transfer in individuals with hemiparesis. Neurorehabilitation, 32(3), 609–615. doi:10.3233/nre-130883