Title: Mental practice in combination with conventional therapy in patients 1-6 weeks post CVA is just as effective as conventional therapy alone in improving performance in daily activities and reducing UE impairments.

Prepared by: Danielle Grall, OTS (grall.dani@uwlax.edu) &
Karin Wilson, OTS (wilson.kari@uwlax.edu)
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CLINICAL SCENARIO:
Client population: Adults 1-6 weeks post CVA.

Treatment context: Treatment occurred in an acute care setting.

Condition/ problem: Stroke is a condition that affects the cerebral vasculature by interrupting blood flow to varying regions of the brain. This interruption occurs when there is a blocked artery or a break in a blood vessel that limits associated brain regions from receiving oxygen and consequentially, results in death among brain cells and potential brain damage (National Institute of Health, 2011). With brain cell death, the functions associated with that region of the brain will also be affected based on the location, degree, and the mechanism of the stroke. When a CVA occurs in the right cerebral hemisphere, an individual may lack nonverbal communication, the ability to learn new information, exhibit behavioral changes and experience hemiparesis on the left side of the body. In addition, damage to the right side of the brain may result in the inability to attend to visual stimuli on the left side of the body (National Stroke Association, 2013). A CVA in the left cerebral hemisphere may affect an individual's speech, comprehension of language, known as aphasia, and result in right - sided hemiparesis (National Stroke Association, 2013). A stroke may also affect the cerebellum or the brainstem. A stroke affecting the cerebellum can result in an inability to coordinate movements, known as ataxia. While a stroke impacting the brainstem will affect critical functions such as breathing, swallowing and attentiveness (National Stroke Association, 2013).

Incidence/prevalence: Today, stroke is the fourth leading cause of death affecting approximately 795,000 individuals a year (National Stroke Association, 2013). Hemiparesis, which is weakness or difficulty moving one side of the body, occurs in about 80% of stroke survivors (National Stroke Association, 2013). Over 50% of patients with upper limb paresis resulting from stroke experience impaired arm function and limitations or dependency on others when completing activities of daily living (ADLs) (Kwakkel et al., 2003). More specifically, according to Stains, McIlroy, and Brooks (n.d.), only 5% of adult stroke survivors regain full function of the upper limb while 20% regain no functional use post stroke (p. 6).

Impact of this problem/condition on the client's level of activity and occupational performance: According to the American Occupational Therapy Association (AOTA, 2008), participation in numerous areas of occupations including ADL's, IADL's, work, leisure, and social participation may be affected depending on the severity of the stroke patient's hemiparesis. These limitations are due to a decline in body functions and structures in the affected UE. More specifically, stroke patients with hemiparesis will experience difficulty in both fine and gross motor tasks and have trouble performing bilateral movements that require grasping and manipulating objects. These limitations will affect a stroke patient's ability to partake in daily activities such as bathing, grooming, hygiene, and driving. In addition, stroke related cognitive impairments such as memory deficits, confusion, and a decline in mental capability will amplify the physical limitations impacting participation in home management, child care and community activities.

Intervention: Mental practice consists of an individual participating in repetitive mental rehearsal and imagining of a motor task within the working memory (movement imagery) without physically performing the task. The purpose of mental rehearsal is to improve motor performance of specific tasks or activities by targeting the cognitive processes that are associated with the required skilled movements (Verbunt. et al,

2008). With mental practice, the individual should go through the steps of the task, concentrating on the movements required and feeling how their body is moving within their imagination (Muratori et al., 2013). In the articles reviewed, the total amount of treatment time devoted to mental practice was 270 hours/6 weeks for Braun et al. (2012), 1260 hours/ 6 weeks for Timmerman et al (2013), and 780 hours/4 weeks for Ietwaart et al (2011).

Why this is an appropriate intervention for occupational therapy: Mental practice is a preparatory method that aims to strengthen newly formed motor pathways to prepare the individual for performance of physical tasks. Mental practice encompasses numerous areas of the Occupational Therapy Framework: Domain & Process 2nd Edition (AOTA, 2008). Performance skills addressed through mental practice include motor and practice skills that allow individuals to gain control of multiple parts of the body. In addition, mental practice aims to enhance muscle endurance, muscle strength, and the mobility of joints of the affected upper extremity. Client factors, specifically eye-hand coordination and bilateral coordination, are also areas that mental practice can refine through repetitive cognitive rehearsal.

Occupational Therapy theory that this intervention is most generally associated with: The usefulness of mental practice is supported by the motor learning theory. This theory proposes that motor learning is necessary for "the acquisition and modification of learned movement patterns over time" (Phipps & Roberts, 2013, p.831). More specifically, this theory emphasizes the importance of experience and practice through repetitive cognitive rehearsal to build and maintain new neural pathways. If this cognitive rehearsal is performed in an accurate and consistent manner, the individual will experience relatively long-lasting and permanent changes in their ability to motor plan and an overall improvement in performance and functional recovery over time (Muratori, Lamberg, Quinn, & Duff, 2013; Phipps & Roberts, 2013).

Science behind the Intervention: After a stroke, damage or death to the motor cortex brain region may occur due to a lack of blood flow. This damage/death of the motor cortex can result in a loss of cerebral function in that area which presents physically as substantial motor dysfunction and sensory impairments. However, due to neuroplasticity, the brain post-stroke is able to reorganize and form new neural pathways to compensate for this damage. Research has found that through neural reorganization, motor activity associated previously with the damaged brain area can be activated by electrically stimulating the intact cortex adjacent to the damage (Nudo, Wise & SiFuentes, 1996). This suggests that after local damage to the motor cortex, new motor pathways can be created in intact brain regions through unmasking, which utilizes existing neural pathways to take over the function of the damaged pathways, or sprouting, which is the development of new neural connections in response to functional demands (Pedretti, 2006). However, in order to strengthen these newly found motor pathways, practice and repetition, which is provided through mental practice is required. Mental practice is thought to be effective in improving skilled movement because when performed, the neural processes utilized when imagining a movement are very similar to the neural processes necessary for the actual physical performance of the movement (Muratori et al., 2013). More specifically, research has found that mental practice increases the neural activity (Page, Szaflarski, Eliassen, et al., 2009) and perfusion (Jackson, Lafleur, Malouin, et al., 2003) of similar areas of the brain as when the actual movement is performed. This increased activity and perfusion has been found in the motor cortex, which is responsible for the execution of voluntary movement, and the premotor cortex, which is involved in the planning and priming of voluntary motor movements (Butler & Page, 2006). Lastly, although no overt movement is experienced with mental practice, EMG studies have found that low level muscle activity (sibmovement activity) still occurs (Muratori et al., 2013).

FOCUSED CLINICAL QUESTION:
Patient/Client Group: Adults who are 1-6 weeks post stroke (CVA)
Intervention: Mental practice in combination with Conventional therapy
Comparison Intervention: Conventional therapy
Outcomes: Reduction of UE impairment and improved performance in daily activities

SUMMARY:
What is the effectiveness of mental practice in combination with conventional therapy compared to conventional therapy alone on performance in daily activities and reduction of UE impairment in patients 1-6 post stroke (CVA)?
Search
A total of eight different data bases have been searched and a total of eight relevant articles were found. Three of the relevant RCT articles were critiqued for this CAT. These articles include Braun et al. (2012), Ietswaart et al. (2011) and Timmerman et al. (2013). Braun et al. (2012) had a PEDro score of 6 while Timmerman et al. (2013) and Letswaart et al. (2011) has PEDro scores of 7. All articles had a 1b level of evidence. These three articles were chosen to be individually appraised because they all had high PEDro scores and looked at similar populations, outcome measures, and dependent variables. Based on the findings of these three studies, mental practice in combination with conventional therapy in patients 1-6 weeks post CVA is just as effective as conventional therapy alone in improving performance in daily activities and reducing UE impairments.

CLINICAL BOTTOM LINE: There is strong evidence that the use of mental practice in combination with conventional therapy in patients 1-6 weeks post CVA is just as effective as conventional therapy alone in improving performance in daily activities and reducing UE impairments.

Limitation of this CAT: This critically appraised topic has not been peer reviewed.

SEARCH STRATEGY:

Table 1: Search Strategy

Databases Searched	Search Terms	Limits used	Inclusion and Exclusion Criteria
1.) CINAHL Plus with Full Text (EBSCOHOST) 2.) Google Scholar 3.) Science Direct 4.) OT seeker 5.) Cochrane Central Register of Controlled Trials 6.) UpToDate 7.) OVID data base 8.) EBSCO HOST	"Mental practice + stroke" "Mental imagery + stroke" "Mental practice + subacute stroke" "Mental practice + CVA" "Mental practice + function" "Mental practice in subacute stroke + functional use"	"and"	Inclusion: Full text only English only Adults Exclusion: Articles older than 2005 Lower extremity Abstracts only

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 (Name, Year)
Level 1a	Systematic Reviews or Meta-analysis of Randomized Control Trials	1	The Cochrane Library	(Barclay- Goddard, 2011)
Level 1b	Individualized Randomized Control Trials	7	Brain: A Journal of Neurology Journal of the American Medical Director Association (JAMDA) Journal of the American Medical Director Association (JAMDA) Hong Kong Medical Journal Stroke European Journal of Physical & Rehabilitation Medicine BMC Neurology	(Ietswarrt et al., 2011) (Timmermans et al., 2013) (Braun et al., 2012) (Liu, 2009a) (Liu et al., 2009b) (Riccio et al., 2010) (Verbunt et al., 2008)
Level 2a	Systematic reviews of cohort studies			

Level 2b	Individualized cohort studies and low quality RCT's (PEDro < 6)			
Level 3a	Systematic review of case-control studies			
Level 3b	Case-control studies and non-randomized controlled trials			
Level 4	Case-series and poor quality cohort and case-control studies			
Level 5	Expert Opinion			

STUDIES INCLUDED

Table 3: Summary of Included Studies

	Study 1 (Braun, Beurskens, Kleynen, Oudelaar, Schols & Wade, 2012)	Study 2 (Ietswaart, Johnston, Dijkerman, Joice, Scott, Macwalter & Hamilton, 2011)	Study 3 (Timmermans, Verbunt, van Woerden, Moennekens, Pernot, & Seelen, 2013)
Design	RCT	RCT	RCT
Level of Evidence	Level 1b	Level 1b	Level 1b
PEDro score	6/8	7/8	7/8
Population	36 participants Inclusion Criteria: 1.) 2-10 week post CVA 2.) Cognitive and communication levels sufficient (based on clinical judgment & score on Mini-Mental State Examination). 3.) No rheumatic disease or dementia prior to stroke Control Group: • 9 male participants and 9 female participants • Means days since stroke: 33.6 days	121 participants Inclusion Criteria: 1.) 1-6 months post CVA 2.) Persistent motor weakness (score between 3-51 on Action Research Arm Test (ARAT) 3.) No severe cognitive impairments 4.) No current alcohol or substance abuse 5.) No severe aphasia Attention- Placebo Control Group: • 22 male participants and 17 female participants • Mean days since	42 participants Inclusion Criteria: 1) 2-6 weeks post CVA 2) First stroke ever 3) 18-85 years of age 4) Clinically diagnosed with central paresis of the arm hand, with elbow flexor strength grade 1-3 5) No severe cognitive impairments 6) No severe neurological, orthopedic, cardiac, or rheumatoid impairments before stroke Control Group: • 13 male participants and 8 female

	Experimental Group: • 5 male participants and 13 female participants • Means days since stroke: 42.7 days	stroke: 90.8 days Normal Care Control Group: • 25 male participants and 16 female participants • Mean days since stroke: 80.5 days Experimental Group: • 23 male participants and 18 female participants • Mean days since stroke: 82.0 days	participants • Mean days since stroke: 32.3 days Experimental Group: • 13 male participants and 8 female participants • Mean days since stroke: 36.1 days
Intervention Investigated	Received multi professional therapy following stroke rehab protocol for Dutch guidelines Mental Practice Training was embedded in therapy. Treatment intervention included: Education on MP, teaching MP techniques, practicing and tailoring techniques to the participant, and incorporating overt movements with imagery attempts. A log was given to participants to document unguided mental practice performed outside of therapy. MP Treatment Time: 6 weeks, 3 days a week for 15 out of the 30 minutes of therapy. = A total of 270 hours of therapy denoted to mental practice.	Standard medical care following stroke rehab protocol for Scottish guidelines + Additional MP training was provided. Treatment intervention included: Manual based education on the use of MP techniques. These techniques required the participant to mentally visualize themselves completing elementary movements (ex: opening the hand), progressed to directed movements (ex: grasping something), and lastly required the participant to mentally practice completing common ADL's. Lastly, participants were also trained in the use of mirror and video imagery as well as covert motor imagery activities. In addition, participants received eight 30 minute independent audio-tape guided sessions that were to be	Received therapy as usual following stroke rehab protocol for Dutch guidelines + Additional MP training was provided. Treatment intervention included: Education on MP principles and techniques, followed by tailoring of tasks based on the participant's functional level. For each task, a DVD was utilized as a guide which broke the training into three steps. Steps included verbal explanation and demonstration of the movement, mentally practicing the movement without verbal explanation, and lastly engaging in task performance without guidance. MP Treatment Time: Patients had to complete MP DVD training at least three times a day for 10

	MP + Conventional Therapy Total: 540 hours	completed as "homework". A log was given to participants to document unguided mental practice. MP Treatment Time: 45 minutes, 3x a week for 4 weeks + 30 min independent sessions, 2x a week = 780 hours of MP MP + Conventional Therapy Total: Unable to determine as the length of conventional therapy session was not stated.	minutes per session; 6 week intervention. = 1260 hours of MP MP + Conventional Therapy Total: Unable to determine as the length of conventional therapy session was not stated.
Comparison Intervention	These participants received therapy as usual and were advised to complete "homework" that included performing "tasks that were hard for the participant to complete in therapy" in order to match the intervention groups unguided imagery training. A log was given to participants to document unguided therapy. Treatment Time: 30 minutes, 3 days a week, for 6 weeks Total Therapy Received: 540 hours	Attention Placebo Control Group: Standard medical care + Received visual and sensory imagery training. This included mentally visualizing different objects and landscapes, temperatures and smells based on videos and pictures provided. In addition, participants completed eight 30 minute independent audio-tape guided sessions that incorporated visual and sensory imagery as described above as "homework". A log was given to participants to document unguided mental practice. Attention Placebo Control Group: Treatment Time: 45 minutes, 3x a week for 4 weeks + 30 min independent	These participants received therapy as usual as well as training on additional bimanual UE techniques guided by NDT principles. This included active participation of the patient through the use of reflex-inhibiting patterns and key points of control to produce movement. Treatment Time: Patients had to complete at least three times a day for 10 minutes each session; 6 weeks= 210 hours weekly. Total: 1,260 hours Total Therapy Received: Unable to determine as the length of conventional therapy session was not stated.

<table>
<tr><td></td><td></td><td>sessions, 2x a week.

Total: 780 hours

Normal Care control group:
received standard medical care and no added training

Total Therapy Received: Unable to determine as the length of conventional therapy session was not stated.</td><td></td></tr>
<tr><td>Dependent Variables</td><td>Performance in daily activities and recovery of upper extremity motor function</td><td>Performance in daily activities and recovery of upper extremity motor function</td><td>Performance of daily activities and recovery of upper extremity motor function</td></tr>
<tr><td>Outcome Measures</td><td>Primary outcome
- Numeric rating scale (NRS): Individual rates their performance in specific activities.
Secondary outcomes
-Motricity Index (MI)
-Barthel Index (BI)
-Nine Hole Peg Test (NHPT)</td><td>Primary outcome
-Action Research Arm Test (ARAT)
Secondary outcomes
-Dynamometer
-Barthel Index (BI)
-Modified Functional Limitation Profile</td><td>Primary outcomes
-Fugl-Meyer test (FMT)
-Wolf Motor Function Test (WMFT)
-Frenchay arm test (FAT)
-Frenchay activity index (FAI)
-Accelerometry (ACC)</td></tr>
<tr><td>Results</td><td>Both groups improved on all outcome measures except for the NHPT. However, no significant differences were found between group (p>.05).

Between group differences
<table><tr><td>Outcome Measure</td><td>P-value</td></tr><tr><td>NRS</td><td>.672 (drinking)
.290 (arm activity)</td></tr><tr><td>MI</td><td>.707</td></tr><tr><td>BI</td><td>.463</td></tr><tr><td>NHPT</td><td>.494 (right)
.198 (left)</td></tr></table></td><td>No significant difference between the intervention group and the attention placebo control group (p=.077).

No significant difference in motor imagery between both treatment groups (p=0.52)

Between group differences
<table><tr><td>Outcome measure</td><td>P-value</td></tr><tr><td>ARAT</td><td>.77</td></tr><tr><td>Grip strength</td><td>.60</td></tr></table></td><td>Both groups improved on all outcome measures but no significant between-group differences were found. However, only in the experimental group was a clinically meaningful difference found in arm function before and after training as measured by the FAT.

Between group differences
<table><tr><td>Outcome Measure</td><td>P-value</td></tr><tr><td>FMT</td><td>.47</td></tr><tr><td>WMFT</td><td>.59</td></tr></table></td></tr>
</table>

		Hand Function .98 BI .38 Functional Limitations Profile .98	FAT .28 ACC (Activity ratio, affected/non affected) .76
Effect Size	Nine Hole Peg Test (NHPT) - Left Cohen's d = 0.281 Small effect size Nine Hole Peg Test (NHPT) - Right Cohen's d = 0.107 Small effect size Barthel Index (BI) Cohen's d= 0.012 Small effect size Motricity Index (MI) Cohen's d= .194 Small effect size Numeric Rating Scale (NRS) – drinking Cohen's d = .187 Small effect size Numeric Rating Scale (NRS) – arm activity Cohen's d = .3 Small effect size	Very small effect sizes ($0.00<n^2<0.019$) Upper Limb Impairment (ARAT): ($n^2 = 0.005$) Small effect size Grip strength ($n^2 = 0.00$) negligible to small effect size Hand Function ($n^2 = 0.00$) negligible to small effect size Activities of Daily Living Level (BI) ($n^2 = 0.019$) Small effect size Functional Limitations Profile ($n^2 = 0.00$) negligible to small effect size	Cannot complete due to only medians being reported
Conclusion	This study found that mental practice is just as effective as current standard of care for stroke rehabilitation.	This study found that mental practice paired with motor imagery does not enhance motor recovery in patients early post-stroke.	Trend is seen for more improvement in the experimental group compared to the control group. However, the differences between the groups were not significant enough to suggest that mental practice is more effective than conventional therapy in changing the D.V.'s stated above.

IMPLICATIONS FOR PRACTICE, EDUCATION and FUTURE RESEARCH (Synthesis Section)

Overall Conclusions:

All three studies reviewed for this CAT were randomized control trials according to the Canadian Levels of Evidence Scale. All reviewed articles found no evidence in favor of mental practice in addition to conventional therapy over conventional therapy alone in improving performance in daily activities and reducing UE impairments in adults with acute stroke (1-6 weeks post CVA). In these studies, the first dependent variable, performance in daily activities, was measured by looking at the participant's ability to complete daily tasks such as feeding, bathing, toileting, grooming and dressing. The second dependent variable assessed recovery of upper extremity motor function and was measured by changes in strength, dexterity, gross motor movements, fine motor movements, and coordination abilities of the affected arm and hand. For all reviewed studies, both the experimental and control group experienced improvement in performance of daily activities and a reduction in UE impairments from pretest to posttest. However, results did not find more significant changes in one group over the other. Therefore, there is no supporting evidence suggesting mental practice in addition to conventional therapy is better than conventional therapy alone Timmerman et al. (2013) did however note a trend of more improvement in the experimental group over the control group in upper extremity motor function. For all these studies, small to medium effect sizes were noted showing that the use of mental practice with this population may or may not have clinically relevant outcomes. It is important to note that effect sizes for Timmermans et al. (2013) were unable to be reported due to a lack of data being provided.

All studies implemented varying protocols due to the fact that there are currently no clinical guidelines established for mental practice (Lindsay, Gubitz, Bayley, Hill, Davies-Schinkel, Singh, & Phillips, 2010). Braun et al. (2012) and Timmermans et al. (2013) utilized tailored imagery content that was specific to the patient's abilities, functional level and preference. On the contrary, Ietswaart et al. (2011) provided imagery content that followed an operational manual that did not allow the task to be individualized. Additionally, Braun et al. (2012) and Timmermans et al. (2013) allowed participants in the mental practice group to also engage in physical movements involving the affected extremity following or during the motor imagery tasks. This difference in protocol could have potentially impacted the results since physical movements allows sensory input that mental practice alone does not provide. Overall, results from the studies may have been impacted due to variability in terms of how mental practice protocols were developed, taught and monitored.

For all three studies, conventional therapy was not defined or described directly in the articles. Rather, conventional therapy followed the stroke rehabilitation protocol for both the Dutch (Braun et al., 2013 & Timmermans et al., 2013) and Scottish (Ietswaart et al., 2011) guidelines which were specified in separate documents that were unable to be translated. Since these guidelines also specified the typical treatment dosage of conventional therapy, we were unable to determine the total treatment times for both Timmermans et al. (2013) and Ietswaart et al. (2011). However, since Braun et al. (2012) was the only article that embedded the mental practice intervention into the conventional therapy, total treatment dosage and time spent completing mental practice was stated. For Braun et al. (2012), the total time spent in therapy throughout a 6 week span was 540 hours with 270 hours being devoted to the mental practice intervention. For both Timmermans et al. (2013) and Ietswaart et al. (2011) mental practice was provided in addition to conventional therapy, totaling 780 hours of mental practice within 4 weeks (Ietswaart et al., 2011) and 1260 hours in mental practice within 6 weeks (Timmermans et al., 2013). Overall, there was a large variation in hours spent participating in mental practice between groups. This is another difference between studies that is important to note when interpreting these results. Treatment time for the experimental group was also variable due to the fact that participants were only given a minimum daily time requirement, but were otherwise unrestricted, in terms of how often and how much they participated in unguided mental practice outside of therapy. Therefore, optimal treatment time was unable to be determined from the information obtained from these studies.

Despite the use of different programs, there were distinct similarities between interventions in all three studies: (1) All studies provided education and training on how to use mental practice techniques. (2) Independent mental practice outside of therapy was expected and imagery logs were provided to record

unsupervised practice. This could be problematic as participants may have been inaccurate when reporting time spent practicing and/or documenting completion of either independent mental and/or physical practice. (3) All studies ensured that the control group received similar, if not equal, therapy time and therapist contact as the experimental group.

In conclusion, the results for all three studies demonstrated strong evidence that the use of a 4- 6 week mental practice in addition to conventional therapy with participants 1-6 week post stroke is just as effective in improving performance in daily activities and reducing UE impairments in comparison to conventional therapy alone. Based on the Sackett levels of evidence, strong evidence can be assumed since the three randomized control trials had a PEDro score of 6 or higher and showed similar findings.

Boundaries:

A total of 199 participants were involved in the following 3 RCT. All participants ranged from 2 weeks to 6 months post CVA, with a mean of 54 days post stroke for the experimental group and 52 days post stroke for the control group. For all studies, the control and experimental participants were represented evenly. When looking at all 3 studies, the age range consisted of participants between 18-85 years of age, with an average age of 68 years in the control group and 69 years for the experimental group. All studies excluded participants with severe cognitive impairments. Additionally, Braun et al. (2012) and Timmerman et al. (2013) excluded individuals with severe neurological impairment such as dementia and rheumatic diseases prior to diagnosis of stroke.

Implications for practice:

The results of the studies reviewed demonstrate that mental practice used in combination with conventional therapy in patients 1-6 weeks post CVA is just as effective as conventional therapy alone in improving performance in daily activities and reducing UE impairments. There are numerous factors that must be considered when implementing mental practice protocol into therapy for patients who have experienced a stroke. Before carrying out a mental practice intervention, it is important to ensure that the patient has an adequate level of cognitive functioning and is provided sufficient education and training to successfully engage in mental imagery techniques. An individual's level of cognitive functioning can be determined by completing a cognitive assessment, such as the Mini Mental State Examination or the Vividness of Movement Imagery Questionnaire (VMIQ). It is important to note that mental practice was not used as a stand-alone intervention in the 3 articles selected. Rather, it was used as a supplementary tool used in combination with the standard stroke care.

To date, a standard protocol for mental imagery doesn't exist. Therefore, further research should be conducted to determine the optimal mental practice treatment dosage, the effectiveness of mental practice being embedded within therapy versus being provided outside of therapy as an additional independently guided treatment, as well as the impact of incorporating physical movements into a mental practice protocol. Likewise, further research is needed to determine what forms of mental practice (i.e. DVD, one-on-one therapy, etc.) are most effective and in what context (home or rehabilitation setting). Lastly, future research should look at the effectiveness of mental practice embedded within therapy versus providing mental practice interventions outside of therapy as an additional independently guided treatment.

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