There is strong evidence that LAT is as effective as alternative interventions for improving motor function and moderate evidence that LAT is as effective as alternative interventions for improving unilateral neglect and functional independence in adults 10 days-10 months post right CVA.

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CLINICAL SCENARIO:

Client Population: This CAT specifically looked at adult patients who were between 10 days and 10 months post right cerebrovascular accident (CVA).

Treatment Context: Treatment took place in a hospital, rehabilitation facility, nursing home or home.

Condition/Problem: Following a right CVA, an individual may experience left unilateral neglect. This may be explained by the brain's asymmetric function for the direction of attention, as the right side of the brain is the only hemisphere to direct one's attention to the left side of their world. Left unilateral neglect is a condition that is demonstrated by the inability to respond and orient to the left side of one's body and environment. This lack of attention, along with the frequent occurrence of hemiparesis following a CVA, may further lead to a reduction in the use of the left side of an individual's body, and significantly affect their performance and participation in daily occupations (Radomski & Trombly Latham, 2008). Additional residual problems may also occur following a CVA, which will depend on the location of the lesion and the extent of damage to the brain (National Stroke Association, 2013). These residual problems may include hemiplegia, language deficits, swallowing difficulties, incontinence, cognitive impairments, or psychological manifestations (Gillen, 2011).

Incidence/Prevalence: According to the Centers for Disease Control and Prevention (2013), 795,000 Americans experience a stroke each year. Luukkainen-Markkula, Tarkka, Pitkanen, Sivenius and Hamalainen (2009) suggest that unilateral neglect occurs in approximately 30% of individuals who experience a CVA. Left unilateral neglect is more prevalent, affecting 40-50% of patients who experienced a right CVA (Luukkainen-Markkula et al., 2009).

Impact of the Problem on Activity/Performance: Unilateral neglect and hemiparesis are typically associated with poor motor recovery following a CVA (Robertson et al., 2002). Together, these two conditions interfere with the client's ability to position, move, and use their body in space, acting as barriers to occupational performance. When referencing the International Classification of Function and Disability (ICF), there are several areas or levels of analysis that are typically affected by a stroke, such as body functions/structures, activity, participation, and quality of life. Considering the dynamic interactions between each of the levels of analysis, deficits in one area may affect the return of numerous functions in another. The client's ability to complete their ADLs or IADLs, as well as their capacity to participate in valued occupations, will all be impacted. Additionally, stroke patients typically experience a decline in independence, self-efficacy, well-being, and quality of life (Pendleton & Schulz-Krohn, 2006). These disruptions in one's well-being often lead to depression and anxiety.

Intervention: Limb activation training (LAT) is an intervention designed to call attention to the affected limb and the neglected hemispace of an individual post right CVA. The purpose of LAT is to address left unilateral neglect through the movement of the contralesional (left) limb within the neglected hemispace. This is said to activate and re-organize the affected right hemisphere of the brain and result in the improvement of left neglect, whereas movement of the ipsilateral (right) limb would activate the left hemisphere and further inhibit the already damaged right hemisphere. Whether LAT is performed through verbal cueing, a limb activation device (LAD) that delivers sensory cues, or passive motion, any movement of the affected limb in the left hemispace is considered the foundation for this intervention (Eskes & Butler, 2006; Robertson et al., 2002).

Why is the intervention appropriate for OT?: Limb activation training is a remedial and preparatory intervention as it prepares the limb and the client to attend to the neglected hemispace while participating in occupations. It is believed that activating the contralesional limb in the neglected hemispace engages the client and their neglected limb in occupations and facilitates a reduction of unilateral neglect, which has been shown to be a barrier to motor recovery and ADL functioning following a stroke. This further promotes one's ability to learn how to direct their attention to the left side of their world and use their affected limb while performing their daily occupations.

OT Theoretical Basis: LAT for the treatment of unilateral neglect is supported by the motor learning and motor control frame of reference. Motor learning is based on the idea that practice and experience can lead to the acquisition of movement patterns overtime. As a result, motor control develops and the body is able to produce voluntary and purposeful movements (Pendleton & Schultz-Krohn, 2006). Motor learning and motor control depend on the brain's ability to reorganize itself, also known as neuroplasticity, and is the basis for motor recovery following a CVA. Robertson et al. (2002) suggest that the recovery of function in the affected limb is largely dependent on the process of learning and in turn is dependent on attention, perception and response to stimuli. Learning and reorganization of the brain is said to be achieved through LAT.

Science Behind the Intervention: Due to the properties of neuroplasticity, the central nervous system (CNS) is able to reorganize itself after an injury such as a stroke. The CNS has the ability to restore existing pathways or create new neuronal connections, which can be achieved through interventions that stimulate damaged pathways in the brain, such as LAT (Pendleton & Schultz-Krohn, 2006). When an individual experiences a right CVA, unilateral neglect of the body and space may occur as a result of damaged spatial systems in the right hemisphere of the brain. In addition, a decrease in left-sided motor function may occur following a right CVA. When an individual activates their left limb in their left hemispace, or engages in LAT, they are stimulating previously existing pathways or laying down new connections within these affected motor and spatial systems in the right hemisphere of their brain, which may result in the recovery of these damaged systems (Gillen, 2011). Therefore, through LAT and the reorganization of the right hemisphere of the brain, unilateral neglect and motor function may improve.

FOCUSED CLINICAL QUESTION:

- **Patient/Client Group:** This CAT specifically looked at adults who were between 10 days and 10 months post right CVA.
- **Intervention:** Limb activation training (LAT)
- **Comparison Intervention**: LAT was compared to alternative treatments.
- **Outcome(s):** The main outcomes are increased functional independence, increased motor function and decreased unilateral neglect.

SUMMARY:

Clinical question: What is the effect of limb activation training on improving unilateral neglect, motor function, and functional independence compared to alternative interventions for adults 10 days-10 months post right cerebrovascular accident (CVA)?

Search: Eight databases were searched and fourteen relevant articles were located. Three randomized control trials were chosen to be critiqued because they were of the highest evidence and the most recent. The randomized control trials that were used, Fong et al. (2013), Luukkainen-Markkula et al. (2009), and Robertson et al. (2002), displayed the following PEDro scores: 6/10, 5/10, 8/10, respectively.

Findings: Based on the three articles reviewed, the results suggest that limb activation training is as effective as alternative interventions for improving unilateral neglect, motor function, and functional independence in adults 10 days-10 months post right CVA.

CLINICAL BOTTOM LINE: There is strong evidence that LAT is as effective as alternative interventions for improving motor function and moderate evidence that LAT is as effective as alternative interventions for improving unilateral neglect and functional independence in adults 10 days-10 months post right CVA.

Limitation of this CAT: This critically appraised paper (or topic) was a course assignment and has been reviewed only by the course instructor. It has not been peer reviewed.

SEARCH STRATEGY:

Table 1: Search Strategy

Databases Searched	**Search Terms**	**Limits Used**	**Inclusion and Exclusion Criteria**
1. Health Professions Database 2. Journals @Ovid 3. Medline with full text 4. OT seeker 5. Cochrane Database of Systematic Reviews 6. PEDro 7. OT Search (AOTA) 8. CINAHL PLUS with Full Text	• Limb activation training, CVA • Stroke, limb retraining • Cerebrovascular accident, visual neglect • Limb activation training • Limb activation • Unilateral neglect • Left neglect, treatment • Unilateral neglect, limb activation • Stroke, rehabilitation • Stroke, motor function • Neglect rehabilitation • Lateralized attention, stroke • Left neglect, stroke • Limb activation, stroke, left neglect • Unilateral visual neglect, stroke	• and	Inclusion: • Adults with R CVA • Adults with unilateral neglect • Full text • Peer reviewed • 2000-2013 Exclusion: • Non- R CVA • No unilateral neglect • No limb activation training

RESULTS OF SEARCH:

Table 2: Summary of Study Designs of Articles Retrieved

Level	**Study Design/ Methodology of Articles Retrieved**	**Total # Located**	**Database Source**	**Citation (Name, Year)**
Level 1a	Systematic Reviews or Meta-analysis of Randomized Control Trials	0		
Level 1b	Individualized Randomized Control Trials	3	*Neuropsychological Rehabilitation* *Clinical Rehabilitation* *Neuropsychological Rehabilitation*	Robertson et al., 2002 Fong et al., 2013 Polanowska et al., 2009
Level 2a	Systematic reviews of cohort studies	0		
Level 2b	Individualized cohort studies and low quality RCT's (PEDro < 6)	1	*Restorative Neurology and Neuroscience*	Luukkainen-Markkula et al., 2009
Level 3a	Systematic review of case-control studies	0		
Level 3b	Case-control studies and non-randomized controlled trials	1	*Restorative Neurology and Neuroscience*	Eskes & Butler, 2006
Level 4	Case-series and poor quality cohort and case-control studies	3	*Archives of Physical Medicine and Rehabilitation*	Eskes et al., 2003

			Neuropsychological Rehabilitation *Frontiers In Human Neuroscience*	Maddicks, Marzillier, & Parker, 2003 Pitteri et al., 2013
Level 5	Expert Opinion	6	*Physical Therapy* *Neuropsychological Rehabilitation* *Neuropsychological Rehabilitation* *Frontiers In Human Neuroscience* *Neuropsychological Rehabilitation* *Restorative Neurology and Neuroscience*	Brunila et al., 2002 Bailey, Riddoch, & Crome, 2002 O'Neill & McMillan, 2004 Reinhart et al., 2012 Samuel et al., 2000 Wilson et al., 2000

STUDIES INCLUDED:

Table 3: Summary of Included Studies

	Study 1 (Fong et al., 2013)	**Study 2 (Luukkainen-Markkula et al., 2009)**	**Study 3 (Robertson et al., 2002)**
Design	RCT	RCT	RCT
Level of Evidence	1b	2b	1b
PEDro score	6/10	5/10	8/10

Population	-40 subacute patients with right CVA, left hemiparesis, and unilateral neglect -Age: 51-81 -Time post CVA (days) Experimental group: 24.3 ± 18.5 Control group: 22.3± 12.0 (all within 8 weeks of stroke) -No significant differences were found between groups on demographic baselines.	-12 patients with left unilateral neglect, less than 6 months from stroke -Age: 40-74 -Time post CVA (days) Experimental group: 81.0±64.6 Control group: 95.5±63.2 -No significant differences were found between groups on demographic or treatment variables at baseline.	-40 patients with right CVA demonstrating left unilateral neglect (6 with recurrent CVAs, 34 first-time CVAs) -Age: 20-75 -Time post CVA (days) Experimental group: 152.8±142.4 Control Group: 152.1±117.9 -No significant differences were found between groups on demographic or treatment variables at baseline.
Intervention Investigated	**<u>Limb activation and sensory cueing:</u>** -Patients wore a wristwatch device, on the wrist of the hemiplegic arm that emitted vibration and auditory signals as a cue to respond with 5 consecutive movements of their hemiplegic arm. These cues came in 5 minute intervals for 3 hours. The device also recorded the amount of arm movement in both vertical and horizontal directions.	**<u>Arm activation training:</u>** -One patient received active arm activation training, comparable to CIMT, as they had sufficient left arm function -5 patients without sufficient left arm functioning: For 50% of the training hours, the left arm was placed in a push-pull device that activated the arm in the left hemispace. -For the other 50% of the training hours, the left arm was moved passively	**<u>Limb activation training plus perceptual training:</u>** -In conjunction with perceptual training, auditory signals were emitted from a wristwatch device attached to the patient's L wrist, leg or shoulder. Initially, the device emitted a sound every 30 seconds that the L UE was *not* moved. Once the patient moved their limb, the device reset itself. -12 week treatment period, 1 session/week for 45 minutes. -Total time: 9 hours

	-Patients were asked to wear the sensory device daily for 3 consecutive waking hours over 3 weeks (excluding the weekend). -Total time wearing device: 45 hours -Patients also engaged in a 3 week period of conventional rehab (speech therapy, occupational therapy, physiotherapy, and patient/family discussions) while wearing wristwatch.	by the therapist. Functional electrical stimulation (FES), sensory electrical stimulation or therapist aided stretching were used to activate the left arm in the left hemispace. -21-30 hours of left arm activation training for a 3-week period; combined with other therapies (physical therapy, occupational therapy and group therapy) -Total time: 48 hours	
Comparison Intervention	**<u>Sham control:</u>** -3 week period of conventional rehab while wearing a sham sensory device (did not provide the cueing to move the arm). -Patients were asked to wear the sham sensory device daily for 3 consecutive waking hours per day for 3 weeks (excluding the weekend). -Total time wearing device: 45 hours	**<u>Visual scanning training:</u>** -3 procedures with varying degrees of difficulty: 1) iReach program: visual scanning from a video screen 2) Reading and copying materials 3) Copying drawings from L to R -3 week period of visual scanning, 4x/week for 1 hour (12 hours) -1 hour of OT, 90 minutes of PT daily -Total time: 48 hours	**<u>Perceptual training:</u>** -12 week period of perceptual training based on the procedure in the *Lessons for the Right Brain* workbook for OTs. In order to complete the tasks within the workbook, patients had to attend to their left side. Patients were trained in visual scanning to the left and also wore an inactive LAD throughout the duration of treatment.

Dependent Variables	1) Unilateral neglect 2) UE motor functions 3) Basic functional performance	1) Unilateral neglect 2) Arm motor function 3) Hand motor function 4) Functional independence	1) Unilateral neglect 2) Left-side arm motor function 3) Functional independence
Outcome Measures	**Unilateral Neglect:** Behavioral Inattention Test (BIT)- conventional subtest **UE motor functions:** Fugl-Meyer Assessment (FMA)- upper extremity motor subscore; Functional Test of the Hemiplegic Upper Extremity (FTHUE) **Basic functional performance:** Functional Independence Measure (FIM)- motor subscale *Outcomes measured post- training and at a 3-week follow up	**Visual Neglect:** BIT (conventional subtest) and Catherine Bergego Scale (CBS OT) **Arm motor performance:** Modified Motor Assessment Scale (MMAS) **Hand Motor Performance:** Wolf Motor Function Test (WMFT) **Functional independence:** FIM, Modified Rankin Scale *Outcomes measured post-training and at 6-month follow-up	<u>**3-6 mos post-training**</u> **Neglect:** CB Rating Scale, BIT, Comb, Razor Test of Personal Neglect and the Landmark Test **Arm motor function:** The Motricity Index of Limb Function **Functional independence:** Barthel Scale of functional independence <u>**18-24 mos post-training**</u> **Neglect:** CB Rating Scale **Arm motor function:** Motricity Index **Functional independence:** Nottingham Extended ADL Scale
Results	*No between group differences were calculated at post-training <u>Between group differences (at follow-up)</u> BIT cancellation tasks: p = 0.908 **BIT drawing tasks: p = 0.034** FIM: p = 0.843	<u>**Pre-post test:**</u> <u>Arm activation group</u> **FIM: p = 0.031** **BIT: p = 0.031** CBS OT: p = 0.063 MMAS: p = 0.063 <u>Visual scanning group</u> **FIM: p = 0.031** BIT: p = 0.063 CBS OT: p = 0.063 **MMAS: p = 0.031**	*Only one statistically significant difference was found/reported. The difference was found in left-sided motor function. **Motoricity Index p = .009**

	FTHUE: p = 0.340 FMA upper limb subscore: p = 0.301 FMA hand subscore: p = 0.358 -The only significant difference between groups was found in the BIT drawing task at follow-up. *All within group differences for each outcome measure were statistically significant at both post-training and follow-up (p < 0.05 and p < 0.01) except for the *sham control group with the FMA hand sub score* at both post-training and follow-up.	<u>**Post-follow up:**</u> <u>Arm activation group</u> FIM: not reported MMAS: p = 0.125 CBS OT: p = 0.063 **BIT: p = 0.031** <u>Visual scanning group</u> FIM: not reported **MMAS: p = 0.031** CBS OT: p = 0.125 **BIT: p = 0.031**	
Effect Size	*Cohen's d = effect size .20 = small .50 = medium .80 = large ***Between group analysis*** <u>**Pre-post:**</u> BIT cancellation tasks: d = 0.25 BIT drawing tasks: d = 0.51 FIM: d = -0.23 FTHUE: d = 0.2 FMA Upper Limb: d = 0.25 FMA Hand: d = 0.42	*Cohen's d = effect size .20 = small .50 = medium .80 = large ***Between groups analysis*** <u>**Pre-post:**</u> FIM: d = 0.09 <u>**Pre-Follow Up:**</u> MMAS: d = -0.01 CBS OT: d = 0.10 BIT C: d = 0.06 ***Within groups analysis*** <u>**AA Pre-post:**</u> FIM: d = 0.58	*Cohen's d = effect size .20 = small .50 = medium .80 = large ***Between groups analysis*** <u>**Pre-post:**</u> Barthel Index: d = -0.25 CB Rating Scale of Neglect: d = 0.13 Motoricity Index: d = 0.53 BIT subtests: d = 0.21 Landmark test: d = 0.00 Comb & Razor Test d = 0.18 <u>**Pre-3mo Follow Up:**</u> Barthel Index: d = 0.04

	<u>**Pre-follow up:**</u> BIT cancellation tasks: d = 0.21 (S) **BIT drawing tasks: d=0.89** FIM: d=0.05 FTHUE: d=0.50 FMA Upper Limb: d=0.57 FMA Hand: d=0.32 ***Within groups analysis** <u>**LAT Pre-Post:**</u> BIT cancellation tasks: d=0.72 BIT drawing tasks: d=1.37 FIM: d=2.1 FTHUE: d=1.0 FMA Upper Limb: d=0.84 FMA Hand: d=0.89 <u>**Sham Pre-Post:**</u> BIT cancellation tasks: d=0.54 BIT drawing tasks: d=0.70 FIM: d=1.95 FTHUE: d=0.6 FMA Upper Limb: d=0.53 FMA Hand: d=0.32 <u>**LAT Pre-Follow Up:**</u> BIT cancellation tasks: d=0.82 BIT drawing tasks: d=1.58 FIM: d=3.3 FTHUE: d=1.75	MMAS: d = 0.51 CBS OT: d = -1.52 BIT C: d = 0.48 <u>**VS Pre-post:**</u> FIM: d=0.57 MMAS: d=0.77 CBS OT: d=-0.59 BIT C: d=0.43 <u>**AA Pre-Follow Up:**</u> FIM: not reported MMAS: d=0.83 CBS OT: d=-2.61 BIT C: d=0.87 <u>**VS Pre-Follow Up:**</u> FIM: not reported MMAS: d=0.90 CBS OT: d=-0.84 BIT C: d=0.73	CB Rating Scale of Neglect: d = 0.25 Motoricity Index: d = 0.19 BIT subtests: d = 0.08 Landmark test: d=-0.45 Comb & Razor Test d=0.00 <u>**Pre-6mo Follow Up:**</u> Barthel Index: d=-0.11 CB Rating Scale of Neglect: d=0.26 Motoricity Index: d=0.27 BIT subtests: d=0.02 Landmark test: d=-0.03 Comb & Razor Test d=0.09 <u>**Pre-18-24mo Follow Up:**</u> Nottingham Extended ADL scale: d=-0.20 CB Rating Scale of Neglect: d=0.26 Motoricity Index: d=0.41 ***Within groups analysis** <u>**LAT + PT Pre-post:**</u> Barthel Index: d=-0.04 CB Rating Scale of Neglect: d=-0.13 Motoricity Index: d=0.30 BIT subtests: d=0.43 Landmark test: d=0.46 Comb & Razor Test d=0.27 <u>**PT Pre-post:**</u> Barthel Index: d=0.22 CB Rating Scale of Neglect: d=-0.24 Motoricity Index: d=0.11 BIT subtests: d=0.19 Landmark test: d=0.40 Comb & Razor Test d=0.18 <u>**LAT + PT Pre-3 mo:**</u>

	FMA Upper Limb: d= 1.3 FMA Hand: d=1.13 **Sham Pre-Follow Up:** BIT cancellation tasks: d=0.69 BIT drawing tasks: d=0.51 FIM: d=2.71 FTHUE: d=0.9 FMA Upper Limb: d=0.67 FMA Hand: d=0.62		Barthel Index: d=0.23 CB Rating Scale of Neglect: d=-0.07 Motoricity Index: d=0.43 BIT subtests: d=0.43 Landmark test: d=0.17 Comb & Razor Test: d=-0.07 **PT Pre-3 mo:** Barthel Index: d=0.25 CB Rating Scale of Neglect: d=-0.31 Motoricity Index: d=0.19 BIT subtests: d=0.31 Landmark test: d=0.59 Comb & Razor Test d=-0.09 **LAT + PT Pre-6mo:** Barthel Index: d = 0.05 CB Rating Scale of Neglect: d=0.16 Motoricity Index: d=0.47 BIT subtests: d=0.43 Landmark test: d=0.54 Comb & Razor Test: d=0.13 **PT Pre-6mo:** Barthel Index: d=0.16 CB Rating Scale of Neglect: d=-0.11 Motoricity Index: d=0.15 BIT subtests: d=0.37 Landmark test: d=0.48 Comb & Razor Test d=0.09 **LAT + PT Pre-18-24mo:** **Nottingham Extended ADL scale: d = 2.07** CB Rating Scale of Neglect: d=-0.34

			Motoricity Index: d=0.47 **<u>PT Pre-18-24mo:</u>** **Nottingham Extended ADL scale: d = 2.35** CB Rating Scale of Neglect: d=-0.56 Motoricity Index: d=0.01
Conclusion	-The results of this study suggest that LAT had a significant improvement for unilateral neglect, UE motor function, and functional independence within the treatment group. However, there is no significant difference between LAT using a sensory cueing device **and** a sham treatment in improving UE motor function, basic functional performance, or unilateral neglect (despite significant improvements and a large effect size in 1 of the 2 unilateral neglect measurements). -The small effect sizes between groups yet large effect sizes within groups suggest that LAT is as effective as sham treatment for improving UE motor function,	-LAT had a significant effect on functional independence at post-rehab and on unilateral neglect at post-rehab & a 6 month follow-up -The small effect sizes between groups suggest that LAT is as effective as visual scanning in improving unilateral neglect and functional independence. -Overall, both interventions appear to be almost equivalent in regards to improving unilateral neglect and functional independence.	-The results suggest that LAT can significantly improve left-sided motor function. The large effect size at 18-24 months may display the natural improvement in function following stroke as time continues. -No evidence was found to support the use of LAT compared to PT for unilateral neglect, motor function, and functional independence. -LAT is a cost effective treatment as it can be incorporated during normal therapy and can provide effective treatment for motor function when combined with perceptual training.

	unilateral neglect, and functional performance. -It is also suggested that LAT may be useful for promoting hand performance, as within the LAT group there was a significant change in hand impairments, whereas there were no significant changes in hand impairments within the sham treatment group. -Overall, LAT may be clinically useful in improving unilateral neglect, UE motor function, and basic functional performance (ADLs).		

SYNTHESIS: IMPLICATIONS FOR PRACTICE, EDUCATION and FUTURE RESEARCH

Overall conclusions:

All three articles reviewed in this CAT were randomized control trials. Each article measured similar outcome variables that were relevant to this CAT, including unilateral neglect (the inability to respond and orient to the affected side of one's body and environment), motor function (the ability to move one's affected extremity), and functional independence (the level of assistance required to perform daily activities).

While there were no statistically significant differences in unilateral neglect between LAT and the alternative interventions (visual scanning training, perceptual training or a sham treatment) within each study, Luukkainen-Markkula et al. (2009) and Fong et al. (2013) found statistically significant improvements in unilateral neglect following LAT both post-training and at a follow-up. In addition, Luukkainen-Markkula et al. (2009) and Fong et al. (2013) found large effect sizes within the groups who received LAT in unilateral neglect. Robertson et al. (2002) found that LAT with perceptual training did not significantly improve unilateral neglect, and produced small effect sizes. Therefore, LAT was found effective for improving unilateral neglect in two out of the three studies in this CAT.

Luukkainen-Markkula et al. (2009) and Fong et al. (2013) also found statistically significant improvements in functional independence within the LAT group. These findings also demonstrated large effect sizes for this variable. Again, Robertson et al. (2002) did not find that LAT with perceptual training significantly improved functional independence, and this study's effect sizes were small, except for a large effect size found 18-24 months following treatment. There were no statistically significant differences in functional independence between LAT and the alternative interventions within each study. Therefore, LAT was found effective for improving functional independence in two out of the three studies in this CAT.

Motor function, or the ability to move one's affected extremity, was improved following LAT for two out of the three studies in this CAT. Robertson et al. (2002) and Fong et al. (2013) found statistically significant improvements in motor function following LAT, along with large effect sizes within this group. Luukkainen-Markkula et al. (2009) did not find any statistically significant improvements in motor function within the LAT group; however, a large effect size was found in this study for motor function following LAT. There were no statistically significant differences in motor function between LAT and the alternative interventions within each study. Therefore, LAT was found to be as effective for improving motor function.

Differences among the three studies may have had an impact on these results for each outcome variable. While Robertson et al. (2002) provided LAT once a week over a 12-week period for a total of 9 hours, Fong et al. (2013) and Luukkainen-Markkula et al. (2009) provided LAT over a 3-week period, 5 times a week, for a total of 45 hours and 21-30 hours, respectively. Therefore, the intensity and total time LAT was delivered may have likely accounted for the differences between studies. Each study implemented different LAT procedures, and while all participants demonstrated unilateral neglect, motor function abilities prior to receiving LAT were different between studies. Robertson et al. (2002) and Fong et al. (2013) provided LAT through a limb activating device (LAD), which required a sufficient level of limb function in order to carry out movement following the cue from the device. Luukkainen-Markkula et al. (2009) provided LAT through active or passive arm activation; this LAT procedure did not require a specific level of limb mobility.

The outcome measures used in this study may also have impacted the results. All three studies used the Behavioral Inattention Test (BIT) to measure unilateral neglect, yet there were no commonalities between the three studies in regards to outcome measures for motor function. In addition, Fong et al. (2013) and Luukkainen-Markkula et al. (2009) used the Functional

Independence Measure (FIM) to measure functional independence, while Robertson et al. (2002) used the Barthel Scale of functional independence and the Nottingham extended ADL scale. This study did not find improvements in functional independence within the LAT group, only a large effect size 18-24 months following treatment. However, this may be due to the natural improvement one experiences following stroke. It is possible that the FIM may have been more sensitive to identifying an improvement in functional independence following LAT.

Between groups analyses within the three studies did not find results indicating that LAT was more effective than alternative treatments. However, for each outcome variable, large effect sizes and significant improvements were found within at least 2 out of 3 LAT groups. The results of two studies found that LAT alone was effective for improving unilateral neglect and functional independence. Fong et al. (2013) and Luukkainen-Markkula (2009) found similar results; however had a PEDro scale of 6/10 and 5/10, respectively. This indicates that the level of evidence for unilateral neglect and functional independence is moderate for this CAT. The results of two studies also found that LAT alone and with perceptual training was effective for improving motor function. Fong et al. (2013) and Robertson et al. (2002) found similar results, and had a PEDro scale score of 6 and 8, respectively. This indicates that the level of evidence for motor function is strong for this CAT. Therefore, there is strong evidence that LAT is as effective as alternative interventions for improving motor function and moderate evidence that LAT is as effective as alternative interventions for improving unilateral neglect and functional independence in adults 10 days-10 months post right CVA.

Boundaries:

The three articles reviewed in this CAT examined 92 individuals recovering from a right hemisphere CVA. Participants ranged from 20-81 years old and were approximately 10 days to 10 months post CVA (i.e. the subacute-chronic phase of recovery). Each of the three studies had their own inclusion and exclusion criteria; however, there were a few commonalities between all three. All participants had to be experiencing unilateral neglect following a diagnosed right hemisphere CVA, which was determined by scores on the BIT conventional subtest.

In addition, participants were excluded if they were left handed and if they had a history of or were currently experiencing psychiatric disorders or co-existing diseases, such as low vision, neurological diseases, or any disorder that may cause a cognitive decline. These participant characteristics describe the population that the results and evidence of this CAT may apply to. The reviewed studies took place in variety of settings. Treatment took place in a hospital, rehabilitation facility, nursing home or in the patient's home. Despite these differences, the evidence suggests that LAT has the potential to be administered in various settings.

Implications for practice:

The studies reviewed in this CAT provide evidence that different types of LAT (sensory cueing, active and passive movement or stimulation) are as effective as alternative treatments in improving unilateral neglect, motor function and functional independence in adults recovering from a right CVA. Therefore, LAT is an intervention that can be tailored to fit the needs of each client. LAT was found to be as equally effective as visual scanning training alone in improving unilateral neglect and functional independence (Luukkainen-Markkula et al., 2009). It was also found to be as effective as conventional therapy in improving all three dependent variables (Fong et al., 2013). In these studies, LAT was found to be the most effective when implemented for 21-45 hours over a 3 week period. However, the optimal treatment time cannot be concluded from these studies. In addition, participants who demonstrated at least some active limb movement had greater improvements in motor function following LAT.

There is strong evidence that LAT is as effective as alternative interventions for improving motor function and moderate evidence that LAT is as effective as alternative interventions for improving unilateral neglect and functional independence in adults 10 days-10 months post right CVA. Further research needs to be conducted in order to determine a specific LAT protocol and to compare the different types of LAT.

Reviewed Articles

Fong, K., Yang, N., Chan, M., Chan, D., Lau, A., Chan, D., Cheung, J., Cheung, H., Chung, R., & Chan, C. (2013). Combined effects of sensory cueing and limb activation on unilateral neglect in subacute left hemiplegic stroke patients: a randomized controlled pilot study. *Clinical Rehabilitation*, *27*(7), 628-637. doi:10.1177/0269215512471959

Luukkainen-Markkula, R., Tarkka, I. M., Pitkänen, K., Sivenius, J., & Hämäläinen, H. (2009). Rehabilitation of hemispatial neglect: A randomized study using either arm activation or visual scanning training. *Restorative Neurology and Neuroscience*, *27*, 665-674.

Robertson, I. H., McMillan, T. M., MacLeod, E., Edgeworth, J., & Brock, D. (2002). Rehabilitation by limb activation training reduces left-side motor impairment in unilateral neglect patients: A single-blind randomised control trial.*Neuropsychological Rehabilitation*, *12*(5), 439-454. doi:10.1080/09602010244000228

Related Articles (not individually appraised)

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