CANADIAN STROKE BEST PRACTICE RECOMMENDATIONS

Stroke Rehabilitation Evidence Tables

Rehabilitation of Visual Perceptual Deficits

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on Behalf of the Canadian Stroke Best Practice Recommendations
STROKE REHABILITATION Writing Group

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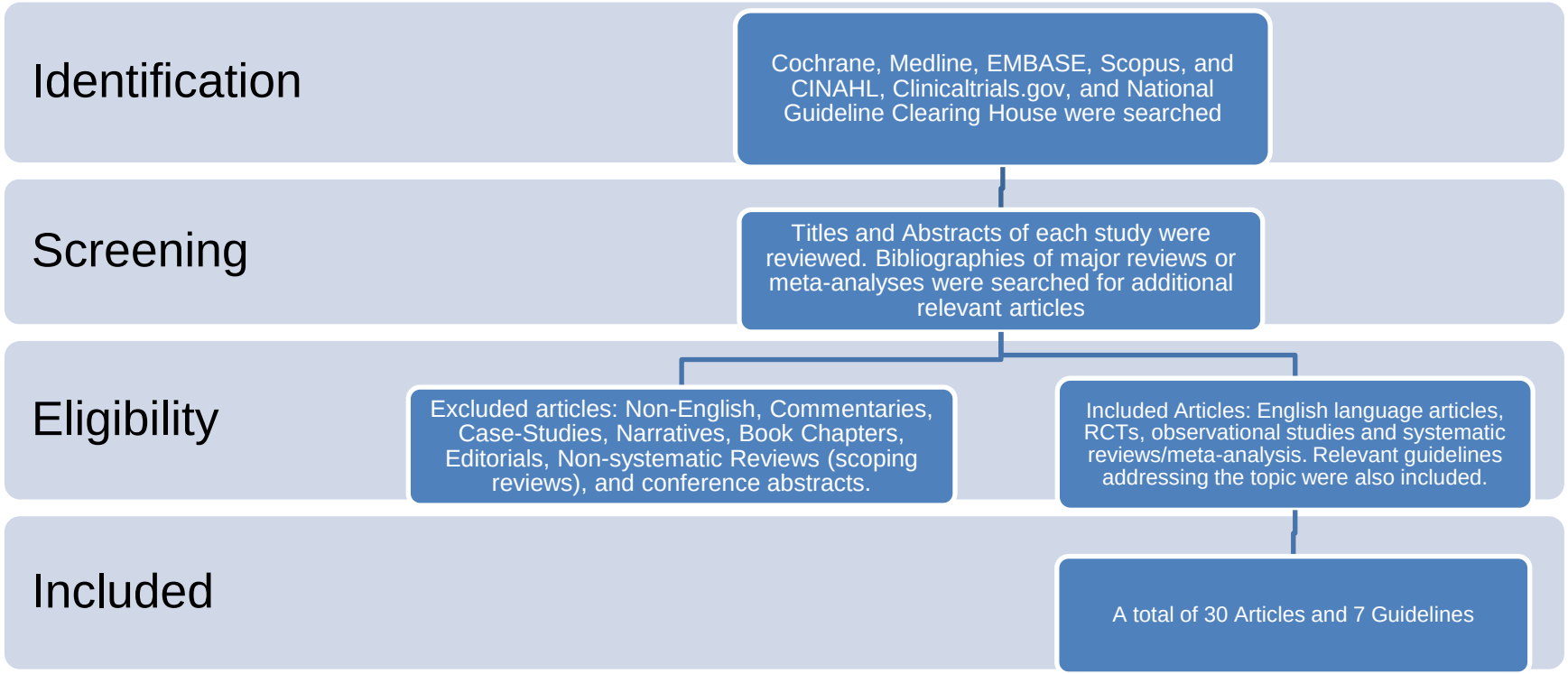
Search Strategy



Cochrane, clinicaltrials.gov, Medline, EMBASE, CINAHL and Scopus were searched using the keywords: Stroke AND ("Visual Disorder" OR "Perception Disorder" OR "Unilateral Neglect" OR Visuoperception") AND (rehabilitation OR therapy OR intervention). For the 2014 update, the section Interventions for Spatial Deficits and Unilateral Neglect was subdivided by type of intervention. The same databases were searched to identify paediatric related evidence using the additional keywords: "(pediatric OR pediatrics OR paediatric OR paediatrics OR youth OR child OR children OR young)". Titles and abstract of each article were reviewed for relevance. Bibliographies were reviewed to find additional relevant articles. Articles were excluded if they were: non-English, commentaries, case-studies, narrative, book chapters, editorials, non-systematic review, or conference abstracts. Additional searches for relevant best practice guidelines were completed and included in a separate section of the review. A total of 30 articles and 7 guidelines were included and were separated into separate categories designed to answer specific questions.

Published Guidelines

Guideline	Recommendations
Stroke Council of American Heart Association; Veteran's Health Administration, DoD **Duncan et al., 2005** **USA**	• Recommended that stroke patients be assessed for visual and spatial neglects, as indicated (Level C). • Recommend treatment for stroke patient with visual/spatial that focuses on functional adaptation (e.g., visual scanning, environmental adaptation, environmental cues, and patient/family education) (Level B evidence).
VaDoD Clinical Practice Guideline for the Management of Stoke Rehabilitation **Dept. of Veterans Affairs. Prepared by The Management of Stroke Rehabilitation Working Group with Support from the Office of Quality and Performance & Quality management Division, United States Army** **USA, 2010.**	• Recommended cognitive rehabilitation for patients with unilateral spatial neglect such as cueing, scanning, limb activation, aids and environmental adaptations (Level B) • Nursing and therapy sessions (e.g. for shoulder pain, postural control, feeding) need to be modified to cue attention to the impaired side in patient with impaired spatial awareness (Level I – or Insufficient evidence)
South African Guideline for Stroke Management **SAMJ, 2010, 100(11), pp775-778 (stroke rehabilitation)**	• Issues of neglect, spatial perception problems and visual difficulties must be considered in the course of OT sessions.
Clinical Guidelines for Stroke Rehabilitation and Recovery **National Stroke Foundation, Clinical Guidelines for Stroke Management, 2010** **Australia**	• Any patient with suspected or actual neglect or impairment of spatial awareness should have a full assessment using validated assessment tools (Grade C) • Patients with unilateral neglect can be trialed with one or more of the following interventions: simple cues to draw attention to the affected side; visual scanning training in addition to sensory stimulation; prism adaptation, eye patching, mental imagery training or structured feedback
Management of patients with stroke: rehabilitation, prevention and management of complications, and discharge planning. A national clinical guideline. **Scottish Intercollegiate Guidelines Network, 2010**	• Patients with visuospatial neglect should be assessed and taught compensatory strategies.

Guideline	Recommendations
Scotland	
Royal College of Physicians, National Clinical Guidelines for Stroke **Intercollegiate Stroke Working Party 2012** **United Kingdom**	**6.42 Perception** ***Recommendations*** **A Any person who appears to have perceptual difficulties should have a formal perceptual assessment (eg the Visual Object and Space Perception battery (VOSP)).** **B Any person found to have agnosia should:** • have the impairment explained to them, their carers and their treating team • be offered a perceptual intervention, ideally within the context of a clinical trial. *6.41.1 Recommendations* A Any patient with a stroke affecting the right cerebral hemisphere should be considered at risk of reduced awareness on the left side and should be tested formally if this is suspected clinically. B Due to the fluctuating presentation of neglect, a standardised test battery such as the Behavioural Inattention Test should be used in preference to a single subtest, and the effect on functional tasks such as dressing and mobility should be determined. C Any patient shown to have impaired attention to one side should be: • given a clear explanation of the impairment • taught compensatory strategies to help reduce impact on functional activities such as reading • given cues to draw attention to the affected side during therapy and nursing procedures • monitored to ensure that they do not eat too little through missing food on one side of the plate • offered interventions aimed at reducing the functional impact of the neglect (eg visual scanning training, limb activation, sensory stimulation, eye patching, prism wearing, prism adaptation training), ideally within the context of a clinical trial.
Stroke: Clinical Practice Guideline **Catalan Agency for Health Technology Assessment and Research, 2007** **Spain**	• Patients with persistent and disabling neglect/spatial inattention must be treated with specific techniques such as cueing, scanning, limb activation, aids and adaptations of the environment (Grade B evidence).

Evidence Tables

Non-Pharmacological Treatment for Perceptual Disorders Post Stroke

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Bowen et al. 2011 **UK** **Systematic Review and Meta-Analysis (Cochrane Review)**	N/A	6 single site trials were identified and included for analysis (n=338). Four of the trials identified were specific to the stroke population. Stroke was the most common etiology for the perceptual deficits of study participants. Time since onset varied from 2 weeks to 5 months, age from 17 to 86 years. Nature and severity of perceptual deficits was often not well described.	RCTs examining the effectiveness of non-pharmacological interventions for the rehabilitation of perceptual deficits post stroke were identified (using electronic and hand-searching techniques (as per Cochrane method). Study authors were contacted where possible for additional data. Identified trials were rated for quality in order to assess risk of bias. Pooled analyses were conducted where possible using fixed effects models. Peto odds ratios were calculated for all binary outcomes. Where outcomes were assessed using different assessment measures, standardised mean differences were calculated. Statistical heterogeneity was assessed using the I^2 statistic.	The primary objective was to examine evidence regarding the effectiveness of interventions re: improvement in activities of daily living up to 6 months post study baseline. Data from standardized outcome measures were used to assess the effect of treatment (e.g. BI, FIM, AMPS). Data from the BI was preferred over the FIM, and over the AMPS in cases where more than one assessment tool was used within the same trial.	All studies provided some form of sensory stimulation, either alone or in combination with another intervention, such as strategy training. The most common form of sensory stimulation identified was practicing tasks that required visual processing, with the guidance/supervision of an occupational therapist. Some studies provided computer-mediated tasks and one study (described below) provided a direct comparison between transfer of training and functional approaches to rehabilitation (Edmans 2000). Only three small trials provided data that could be included in analyses and of these, only 2 compared the provision of an intervention with a placebo condition. Based on the data provided in these trials, there was no significant between group difference in perceptual impairment at the end of the non-pharmacological intervention provided (SMD=0.07, 95% CI -0.29 to 0.43, I^2=0%).
Weinberg et al. 1982 **USA**	CA: ☒ Blinding: Patient ☒ Therapist ☒	35 patients with right brain damage (and no signs of bilateral involvement) following stroke. Mean age was	Participants were randomly assigned to an experimental group receiving 20 hours of perceptual retraining or to	A test battery consisting of 9 tests of verbal cognitive and 12 tests of visuo-cognitive abilities was administered to evaluate the effect of	Post-testing revealed that the experimental group significantly improved on visual-cognitive abilities with gains on 10 of 21 tests: embedded figures, visual simultaneity, conditional cancellation, WAI digit symbol, WAIS picture completion, WAIS block

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
RCT	Assessor ☑ ITT: ☒	64.2 (±9) years in the control condition and 66.8 (±9.8) years. Time since onset of the stroke event ranged from 4 – 100 weeks. Patients with gross USN were excluded.	the control group receiving no perceptual retraining but an extra hour of rehabilitation therapy (usual occupation therapy). The retraining program was intended to help patients establish a systematic strategy around which they might organise complex visual material using anchors within their visual field. Training was provided for one hour per day, 5 days per week over a period of 4 weeks.	treatment. **Assessment points**: Pre- and Post-intervention.	design, WAIS object assembly, Knox cubes, WAIS similarities and Goldstein object sort compared to the control.
Carter et al. 1983 **USA** **RCT**	CA: ☒ Blinding: Patient ☒ Therapist ☒ Assessor ☑ ITT: ☒	33 individuals with acute stroke. Age in the experimental condition averaged 70.5 years (±11.4 years) and 73.4 (±9.2) years in the control condition. There were no significant between group differences on any variables assessed at baseline.	Patients were randomly assigned to either a treatment group receiving cognitive skill remediation training (n=16) or to the control condition (n=17). Cognitive skill remediation was administered on a 1-to-1 basis for 30 to 40 minutes 3 times a week and focused on skill areas that needed improvement (visual scanning, visual-spatial, and time judgement skills). Training continued for a period of 3 to 4 weeks. Participants allocated to the control condition received no remedial skills training but were included in other available stroke program activities during the course of their admission.	The participants were evaluated using a "pre- and post-test" that consisted of 3 tasks; letter cancellation, visual-spatial matching and time estimation. The form of the test was similar, but not identical, on the two testing occasions. **Assessment points**: Baseline, end of training.	Improvement scores were calculated from the pre and post assessments for each of the three outcome tasks. For each of the specific tasks, improvement was significantly greater for the experimental group than for the control group on scanning, visual-spatial and time-judgement skills.

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Lincoln et al. 1997 **UK** **RCT**	CA: ☒ Blinding: Patient ☒ Therapist ☒ Assessor ☑ ITT: ☒	315 individuals with stroke. Mean age was 67.5 (±10.8 yrs) for individuals on the stroke unit and 68.9 (±9.2) years for those on the general ward. There were significantly fewer women than men on the general ward.	Patients were randomly allocated to either a stroke unit (n=176) or conventional unit (e.g. general medical unit) (n=139). Perceptual deficits were noted in 69 patients assigned to the stroke unit and in 54 patients assigned to the general ward. Patients allocated to the stroke unit had improved access to staff including psychologists, OTs etc.	Perceptual impairment was assessed using the Rey Figure Copy Test. Performance of activities of daily living was also assessed using the Barthel Index, Rivermead ADL and Extended ADL scales. The scale used may have depended upon where the patient received rehabilitation care. **Assessment Points**: Baseline, 3, 6, and 12 months.	At study entry, there was no significant between group difference noted in terms of perceptual impairment. At 3, 6 and 12 months, there were significant differences noted such that randomization to treatment on the stroke unit was associated with better performance on the Rey Figure Copy Test when compared to treatment on the conventional ward (U= 6159.5, p=0.001; U=5091, p=0.005; U=4655, p=0.05 at 3, 6 and 12 months respectively). Rey Figure Copy scores were also significant predictors of ADL function, EADL and gross motor function at 12 months.
Edmans et al. 2000 **UK** **RCT**	CA: ☑ Blinding: Patient ☒ Therapist ☒ Assessor ☑ ITT: ☒	80 patients who could complete assessment using the Rivermead Perceptual Assessment Battery (RPAB), had functional use of one hand, speak English and could provide consent. Participants were 69.75 yr of age (±9.1) in the transfer of training group and 67.8 (±11.38) in the functional group).	Participants with perceptual problems were randomized to receive one of two treatment approaches: 1) transfer of training approach focusing on a perceptual task, i.e. spatial relations, (n=40) or 2) to a functional approach group focusing on a specific ADL task for 2.5 hours per week (n=40). Perceptual treatment was provided for 6 weeks in addition to general occupational therapy treatment.	The primary outcome assessment was the RPAB. Other key assessments included the Barthel Index and Edmans ADL Index. **Assessment Points**: Baseline, at the end of treatment (6 weeks).	There were no significant between group differences reported in terms of inpatient length of stay, number of visits made by the attending occupational therapists or the treatment time spent with participants by occupational therapists. In terms of total scores, there were no significant between group differences reported for pre or post treatment RPAB, BI or Edmans ADL scores. Upon examination of individual subtests of the RPAB, Edmans (2000) noted that the transfer of training group demonstrated significant improvement on all subtests except for the following: picture matching, series, animal halves, missing article and 3D copying). The functional group demonstrated significant improvement on all subtests except colour matching, size recognition, animal halves, missing article, sequencing pictures, copying and self-identification. Overall, all patients in both groups tended to improve over time. However, there was no significant difference between groups in the proportion of patients that improved.

Interventions for Spatial Neglect and Visual Field Deficits

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
Systematic Reviews					
Lisa et al. 2013 **Belgium** **Systematic Review**	N/A	15 RCTs that examined different treatment modalities for rehabilitation of unilateral neglect among stroke patients.	Databases (PubMed, Web of knowledge, PEDro) were searched. Quality assessment was conducted using the 9-item Delphi list. Data extraction was performed by the first author. Effect sizes were calculated using Cohen's d.	N/A	Almost all studies found improvements in both groups, but only 7 trials showed statistically significant between group differences in favor of the experimental group. TENS, optokinetic stimulation, somatosensory electrostimulation, mirror therapy and virtual reality training seem to be the most effective treatment methods (d > 0.80). Large effect sizes were found in only four studies.
Yang et al. 2013 **China** **Systematic Review**	N/A	12 RCTs examining treatment strategies for unilateral neglect among 277 stroke patients.	An electronic database search (PubMed/Medline, PEDro, CINAHL, etc.) was conducted to identify trials published in English between January 1997 and June 2012. The search was limited to RCTs involving adults aged 19 or over.	**Primary Outcomes:** Behavioral Inattention Test (BIT).	Prism Adaptation (PA) was the most commonly used intervention while continuous Theta-burst stimulation (cTBS) appeared to be a new approach. Meta-analysis showed that for immediate effects, the BIT conventional sub-score had a significant and large mean effect size (p=0.002) whereas the BIT total score showed a modestly significant mean effect size (p=0.006). No significant mean effect size in sensitivity analysis was found for long-lasting effects across all BIT outcomes. PA appeared to be the most effective intervention based on the results of pooled analysis.
Pollock et al. 2011 **UK**	N/A	13 studies were identified for inclusion (n=344; n=285 post-stroke), 6 of which included a placebo control condition.	RCTs examining the effectiveness of interventions aimed at improving visual field	The primary outcome was functional ability in ADLs as measured with one of the following:	Of the five studies that examined restorative therapy, only 1 included a no-treatment control group: a significant

Systematic Review and Meta-Analysis (Cochrane Review)		5 studies examined each of vision restorative therapy (n=91) and visual scanning training (n=195), whereas 3 examined prism therapy (n=58).	defects subsequent to stroke (using electronic and hand-searching techniques (as per Cochrane method). Identified trials were rated for quality in order to assess risk of bias. Pooled analyses were conducted where possible using random-effects models. Peto odds ratios (OR) were calculated for binary outcomes whereas standardized mean differences (SMD) were calculated for continuous outcomes. Statistical heterogeneity was assessed using the I^2 statistic.	Barthel Index, Functional Independence Measure, Modified Rakin Scale, Rehabilitation Activities Profile, and the Katz Scale. Secondary outcomes included functional ability in extended ADLs, reading ability, visual field measures, balance, falls, depression and anxiety, discharge destination, visual scanning, and quality of life. Endpoints included at the end of the intervention period and at follow-up (ideally at 6-months).	effect of treatment was demonstrated in terms of quality of life (OR=13.0, 95% CI 2.1 to 81.5) but not in terms of visual field outcome (MD=1.02, 95% CI -1.37 to 3.4). 4 of the 5 studies investigating visual scanning training included a no-treatment control condition. Of these, 1 study reported a functional ADLs outcome and 2 reported a visual field outcome: visual scanning was not reported to have a significant treatment effect on either of these outcomes (MD=10.71, 95% CI -2.4 to 23.8; MD=-0.73, 95% CI -3.2 to 1.7, respectively). Conversely, in 3 studies, visual scanning training was demonstrated to have a significant treatment effect on extended ADLs (reading) and scanning outcomes (SMD=0.79, 95% CI 0.3 to 1.3; SMD=1.14, 95% CI 0.3 to 2.0, respectively). 1 of the 3 studies that examined prism therapy included a no-treatment control group. This study reported a significant treatment effect in terms of visual field and scanning outcomes (MD=8.40, 95% CI 4.0 to 12.8; MD=9.8, 95% CI 1.9 to 17.7) but not in terms of functional ADLs or falls (MD=4.0, 95% CI -17.9 to 9.9; RR=1.17, 95% CI -0.34 to 4.0).

Bowen & Lincoln 2007 **UK** **Systematic Review and Meta-Analysis (Cochrane Review)**	N/A	12 studies were identified for inclusion (n=306). Trials that included non-stroke patients were excluded unless more than 75% of the sample were stroke patients or results were reported separately for stroke patients. Studies of patients with general perceptual problems were also excluded unless results were reported separately for a subgroup of patients with neglect.	RCTs examining the effectiveness of cognitive rehabilitation for the treatment of post-stroke neglect. Identified trials were rated for quality in order to assess risk of bias. Pooled analyses were conducted where possible using random-effects models. Odds ratios (OR) were calculated for binary outcomes whereas standardized mean differences (SMD) were calculated for continuous outcomes. Statistical heterogeneity was assessed using the I^2 statistic.	The primary outcome was functional ability as measured with one of the following: Barthel Index, Functional Independence Measure, Frenchay Activities Index, or neglect specific ADL measures. Secondary outcomes included performance on a standardized neglect assessment and discharge destination.	6 studies reported the effect of cognitive rehabilitation on functional disability at the end of treatment while 2 examined the persisting effect of treatment: the intervention was not reported to have a significant impact on functional disability at either discharge or follow-up (SMD=0.26 95% CI -0.2 to 0.7; SMD=0.61, 95% CI -0.4 to 1.6, respectively). 11 studies reported standardized neglect outcomes assessed at discharge: results favoured the intervention group in terms of double letter cancellation (SMD=1.8, 95%CI 0.9 to 2.8), cancellation error (SMD=-0.65, 95%CI -1.3 to -0.01), and line bisection (SMD=-0.84, 95%CI -1.4 to -0.3) but not for single letter, line or shape cancellation or the Behavioural Inattention Test (BIT). 4 studies assessed neglect at follow-up: Cognitive rehabilitation was found to have a significant persisting effect on cancellation errors (SMD=-0.76 95% CI -1.4 to -0.1) and the line bisection (SMD=-1.09, 95% CI -2.0 to -0.2) but not on the BIT. On the basis of one RCT, there is no evidence that cognitive rehabilitation is associated with increased odds of discharge home (OR=1.4, 95% CI 0.45 to 4.35).

Lenses/Eye Patches/Filters					
Beasley & Davis 2013 **UK** **Cross-over RCT**	CA: ☒ Blinding: Subjects ☒ Assessor ☒ ITT: ☒	17 stroke subjects (≤2 years since onset) with neglect and 17 healthy non-stroke age-matched control participants.	Both stroke and control patients were randomized into two groups that underwent three sessions of testing, using the circles search test (CST). The CST consists of 10 rows of shapes containing 1 circle and 9 ellipses, where subjects have identify the circle in each row as quick as possible. In session 1 both groups completed the circles with optimally selected filters. In session 2, group 1 completed the CST with optimal filters, while group 2 completed the CST with grey filters. In session 3, group 1 used grey filter to perform the CST, while group 2 used optimal filters to complete the CST.	**Primary Outcomes:** Visual search response time (VSRT). Outcomes were assessed at baseline and weeks 3 and 7.	Response time increased in both groups with the use of a filter, regardless of type. Among subjects with stroke, initial use of an optimal spectral filter improved VSRT scores (p=0.011), but not error scores (p=0.712). Prolonged use of neither an optimal nor a grey filter improved response time or reduced error scores (p=0.001).
Ching-Yi et al. 2013 **Taiwan** **RCT**	CA: ☑ Blinding: Subject ☒ Assessor ☑ ITT: ☒	24 patients with a right-side cerebral stroke (CIT +EP= 13.0±13.9 months, CIT= 10.1±10.4 months, control= 13.7±14.1 months) and neglect.	Patients were randomized to one of three intervention groups: 1) Constraint-induced therapy (CIT) - use of affected upper extremity to practice functional tasks, 2) CIT + Eye Patch (CIT-EP) - similar to the CIT group except patients wore an eye patch on their right lens during therapy, 3) traditional occupational therapy	**Primary Outcomes:** Catherine Bergego Scale (CBS). Outcomes were assessed at baseline and at the end of the 3 week treatment period.	The CIT+EP and CIT groups had significant improvements in CBS scores compared to the control group (p<0.01, p=0.02). The CIT and the control groups demonstrated better performance with left fixation points than the CIT + EP group (p=0.03, p=0.02). The CIT group had a shorter reaction time than the control group (p=0.01).

			matched in intensity and duration with that of other groups (control).		
Mancuso et al. 2012 **Italy** **RCT**	CA: ☒ Blinding: Patient ☑ Therapist ☑ Assessor ☒ ITT: ☑	29 patients with left visual neglect; however, data is only presented for 22 patients (6 dropouts and 1 outlier were excluded). Patients with severe cognitive impairment were excluded.	Participants were randomized to receive either prismatic lenses (n=13) or neutral lenses (n=9). The prismatic lenses produced a 5 degree deviation to the right of the fixation point. Participants in both groups received pointing exercises during 5, 30 minute rehabilitation sessions. **Duration of Intervention:** 1 week.	Outcome measures included the Albert Test, the Bells Test, the Line Bisection Test, the Bit Test, the Object Searching Test, the Orientation of Lines Test, and the Deal test. **Timing of assessment:** Before and after treatment.	Between-group comparisons did not demonstrate a significant effect of treatment over time for any of the 7 outcome measures. Conversely, within-subject comparisons that included participants from both groups revealed significant improvement on each of the outcome measures, with the exception of the Albert Test, at the end of the one week treatment period ($p<0.05$): the authors concluded that this improvement likely resulted from the pointing exercises that participants in both groups received.
Visual Scanning					
Van Kessel et al. 2013 **Netherlands** **PCT**	CA: ☒ Blinding: Patient ☒ Assessor ☒ ITT: ☒	29 sub-acute (experimental, 157.60 days; control 140.57 days) right hemisphere stroke patients with right visualspatial neglect were included.	Subjects received 30 sessions over 6 weeks. Training consisted of four standardized tasks (digit detection, reading/copying, copying drawings, and figure description) and a driving simulator task. Control patients practiced a single lane tracking task for 2 days per week for 6 weeks. The experimental group was administered the same training schedule, but in weeks 4-6 of the training, the training digit detection task was combined	**Primary Outcomes:** Line cancellation test, Letter cancellation test, Bells test, Line bisection, Reading errors. Outcomes were assessed at baseline and after training.	For both groups, there were significant improvements in line cancellation ($p<0.01$), letter cancellation ($p<0.001$), bells test ($p<0.005$), reading errors ($p<0.005$); however, there was no significant improvement for either group on the line bisection test ($p>0.05$). Post-hoc analysis demonstrated no significant differences between groups on any of the measures.

			with lane tracking on the same projection screen, so as to create a dual task (computerized visual reaction time task designed for training).		
Kerkhoff et al. 2013 **Germany** **RCT**	CA: ☑ Blinding: Patient ☑ Assessor ☒ ITT: ☑	50 patients who were ≥1 month post stroke with left auditory and visual neglect.	Subjects were randomized into one of two groups: 1) smooth pursuit eye movement therapy (SPT) group, or 2) visual scanning therapy (VST) group. Each group received 1-hour sessions for 5 consecutive days.	**Primary Outcomes:** Digit cancellation, visuoperceptual and motor line bisection, paragraph reading, auditory midline. Outcomes were assessed twice before therapy, afterward, and at 2-week follow-up.	Significant improvements were noted in all outcome measures for the SPT group ($p<0.05$ for all) whereas neither visual nor auditory outcomes changed in the VST group ($p>0.05$ for all).
Chan et al. 2013 **China** **RCT**	CA: ☒ Blinding: Subjects ☒ Assessor ☑ ITT: ☒	40 patients with stroke (experimental= 20.10±15.77 days, control= 11.90±6.36 days) and associated unilateral neglect.	Patients were randomized to one of two groups: 1) 12-session visual scanning program for 4 weeks, or 2) standard rehabilitation services (control).	**Primary Outcomes:** Modified Barthel Index (MBI), Mini-Mental State Examination (MM] SE), Behavioural Inattention Test Conventional (BITC), Catherine Bergego Scale (CBS). Outcomes were assessed at baseline and immediately post-intervention.	Compared to control, the visual scanning group had a significant improvement in MBI scores ($p=0.01$) from baseline to follow-up. No significant difference was found for MMSE scores between groups. There was a significant difference in BITC between groups favouring the visual scanning group ($p=0.052$). The CBS scores for the visual scanning group improved to a greater extent than the control group ($p=0.04$).
Ferreira et al. 2011 **Brazil** **RCT**	CA: ☒ Blinding: Patient ☒ Therapist ☒ Assessor ☒ ITT: ☑	10 right-handed patients with hemispatial neglect following right hemisphere ischemic strokes; an additional 5 patients with hemispatial neglect were included in a control group. Patients with locomoter problems or ataxia, Parkinson's disease, dementia, or neurodegenerative disease were excluded. 13.4% of patients screened were eligible for inclusion.	Participants were randomized to receive either visual scanning (n=5) or mental practice (n=5) training; eligible participants who were not willing to participate in a treatment protocol were included in a control group (n=5). Visual scanning involved scanning	Outcome measures included the Behavioral Inattention Test (BIT) and the Functional Independence Measure (FIM). **<u>Timing of assessment</u>:** Before and after the intervention period and at a 3-month follow-up. Control group	Participants in the visual scanning group demonstrated a significantly greater change in BIT score than those in the non-randomized control group ($p<0.05$). Change in score on the BIT for those in the mental practice group did not differ significantly from either group. Although no between group differences were found with respect to total FIM scores, a post-hoc analysis of FIM self-

			from the left side and touching/ mentioning figures or objects. Mental practice involved 2 motor imagery tasks and 2 visual imagery tasks. For both groups, training was provided over 10, 1-hour sessions. **Duration of Intervention:** 5 weeks.	participants were evaluated twice within a 2-month interval.	care items revealed a significantly greater change in sub-score for those in the visual scanning group than those in the control group ($p<0.05$). Change in FIM self-care subscore for those in the mental practice group did not differ significantly from either of the other two groups.
Luukkainen-Markkula et al. 2009 **Finland** **RCT**	CA: ☑ Blinding: Patient ☒ Therapist ☒ Assessor ☒ ITT: ☑	12 patients with left-sided neglect within 6 months of a 1st unilateral right-sided stroke. 42.9% of patients screened were eligible for inclusion.	Participants were randomly assigned to receive either 20 – 30 hours of left arm activation training (n=6) or 10 hours of traditional visual scanning training (n=6). Both interventions were offered as part of a comprehensive program of post-stroke rehabilitation. **Duration of Intervention:** 3 weeks.	Visual neglect was assessed using the Behavioural Inattention Test (BIT). Behavioural neglect was assessed using the Catherine Bergego Scale (CBS). Other assessments included the Functional Independence measure (FIM), the Modified Motor Assessment Scale, the Wolf Motor Function Test, and a neuropsychological assessment battery. **Timing of assessment:** Before and after treatment and at a 6-month follow-up.	In the arm activation condition, visual neglect (BIT) improved significantly over the course of the intervention ($p<0.05$) and from baseline to 6 months ($p<0.05$). Patients in the visual scanning condition demonstrated non-significant improvement from baseline to the end of intervention but demonstrated significant improvement from baseline to 6-month follow-up ($p<0.05$). There was a non-significant trend towards improvement in behavioural neglect (CBS) in both groups over the course of treatment and at 6-month follow-up. Between group comparisons were not reported.
Conventional Rehabilitation					
Dai et al. 2013 **Taiwan** **RCT**	CA: ☒ Blinding: Subject ☒ Assessor ☑	48 subjects with neglect, on average 56.9±38.9 months post stroke (treatment) and 73.9±37.9 months (control) post stroke.	Patients were randomly allocated to one of two intervention groups: 1) vestibular rehabilitation (VR) for 1 month, or 2)	**Primary Outcomes:** Behavioural Inattention Test Conventional (BITC) Subjects were assessed	Both groups improved on BITC scores between baseline and day 14 ($p<0.001$), and baseline and day 28 ($p<0.001$). Between-group differences at baseline,

	ITT: ☒		conventional rehabilitation (control).	at baseline, day 14, and day 28.	day 14 and day 28 were not significant (p=0.840, p=0.214, and p=0.130, respectively).
Kim et al. 2011 **Korea** **RCT**	CA: ☒ Blinding: Patient ☒ Therapist ☑ Assessor ☒ ITT: ☒	24 stroke patients who had unilateral spatial neglect as a result of right hemisphere stroke were recruited. Patients with severe cognitive impairment or aphasia, severely damaged eyesight or sitting balance, or problems with cervical movement were excluded.	Participants were randomized to receive either virtual reality training (n=12) or conventional therapy (n=12). Virtual reality training utilized the IREX system® which involves the use of computer-recognizing gloves that transfer participant responses to a virtual environment. Both groups received therapy for 30 minutes a day, five times a week. **Duration of Intervention:** 3 weeks.	Primary outcome measures included the star cancellation test, the line bisection test, the Catherine Bergego Scale (CBS) and the Korean version of the modified Barthel Index (K-MBI). **Timing of assessment:** Before and after treatment.	Following treatment, both groups demonstrated significant improvement on each of the four outcome measures (p<0.05). Change in score on the star cancellation test and CBS were significantly greater for those in the virtual reality training group, as compared to those in the conventional therapy group (8.7 [SD=7.9] vs. 4.1 [SD=7.2] and 9.1 [SD=6.3] vs. 4.6 [SD=3.8], respectively; both at p<0.05). No between group differences were observed with respect to the line bisection test or the K-MBI; however, it should be noted that only 3 participants from the intervention group and 7 from the control group were included in analysis of line bisection test results, due to problems with the completion of this outcome.
Computer Training					
Jacquin-Courois et al. 2013 **France** **PCT**	CA: ☒ Blinding: Patient ☒ Assessor ☒ ITT: ☒	13 subjects, 7 with chronic homonymous visual field defects and 6 healthy control subjects.	All subjects completed a single training period (300 trials). Subjects were assessed on three different saccadic tasks (a visual search task, a rapid scanning task and a reading task) which were evaluated at three time points on the same day: two before and one after the training period. The computer-based training consisted of a	**Primary Outcomes:** Visual Scanning (Object Absent Object Present$_{Intact}$ Object Present$_{Hemianopic}$)	A significant effect of group (p<0.006) was found with patients being slower than controls on visual scanning. A significant effect of condition (p<0.0005) was found with both groups being slower when looking for an absent target than when looking for a present target (whether in the intact visual field or in the blind visual field). A significant session effect (p<0.02) was found with

			novel ramp-step search paradigm that required subjects to pursue a stimulus (ramp phase) and then saccade to find its location when it suddenly jumped (step phase).		reaction time being faster after the therapeutic intervention than before But with a significant session by group interaction ($p < 0.05$).
Funk et al. 2013 **Germany** **Pre-Post**	N/A	13 subjects with single vascular lesions (right hemisphere=11, left hemisphere=2) suffering from visuospatial deficits, on average 20.7 months post stroke.	All subjects performed repetitive feedback-based computerized training of visual line orientation for 4 weeks.	**Primary Outcomes:** Benton Judgment of Line Orientation Test (JLOT), Mack-Levine Test, Analog Clock reading, Horizontal Writing Cambridge Low Contrast Gratings (HWCLCG), Visual Search performance Outcomes were assessed at baseline and immediately post intervention.	Compared to baseline, JLOT scores improved immediately post intervention ($p<0.10$). For the Mack-Levine test, there were significantly more correct items and reduced processing times in the post training session compared with the baseline sessions ($p<0.01$). Subjects made significantly fewer errors on Analog Clock reading in the post-training session compared to baseline sessions ($p<0.01$). Subjects pants displayed smaller deviations in horizontal writing on HWCLCG in the post training session compared with the baseline sessions ($p<0.01$). Measures of visual search performance unrelated to orientation perception were equivalent before and after training.
Music Therapy					
Pei-Luen et al. 2013 **Taiwan** **Pre-Post**	N/A	16 subjects post stroke (right hemisphere) with unilateral neglect.	Al subjects completed three subtests of the Behavioral Inattention Test while listening to classical music, white noise, or no sound.	**Primary Outcomes:** Star Cancellation Test (SCT), Line Bisection Test (LBT), Picture Scanning Test (PST).	While subjects had the highest scores while listening to classical music and the lowest scores listening to no music, none of the outcome measures demonstrated any significant improvements (SCT, $p=0.463$; LBT, $p=0.061$; PST, $p=0.328$).
Pusswald et al. 2013 **Austria**	N/A	7 subjects with a chronic spatial neglect following stroke.	The training procedure involved acoustic feedback of eye	**Primary Outcomes:** Behavioural Inattention Test Convention (BITC),	Total BITC scores significantly improved between baseline and 15 sessions ($p=0.018$)

Pre-Post			movements. Subjects' heads were fixated to prevent movements and electrodes were placed below each eye. An acoustic feedback was coupled to the detection of eye movement (high sound = eye movement to the right, low sound = movement to the left). Multiple cues were used initially which progressively declined over time. Subjects underwent 15 sessions 3x/wk.	Number Cancellation, Reading Time. Outcomes were assessed at baseline after sessions 10 and 15 and at a follow-up of 3 months.	and baseline and follow-up (p=0.043). Total Number Cancellation scores significantly improved between baseline and 15 sessions (p=0.027) and baseline and follow-up (p=0.028). Total Reading Time scores significantly improved between baseline and 15 sessions (p>0.05) and baseline and follow-up (p=0.046).
Chen et al. 2013 **Taiwan** **Pre-Post**	N/A	19 patients with unilateral neglect after a right hemisphere stroke (mean onset= 15.0±16.7 months).	Patients were instructed to pick three pleasant and unpleasant pieces of music respectively. Patients were then tested individually in the three conditions: 1) pleasant, 2) unpleasant, and 3) white noise as a control condition; conditions were separated by no more than a week. Patients were randomized to one of six trial orders. Patients also completed a visual exploration task where they reported target items in 15 scenes (5 scenes/condition).	**Primary Outcomes:** Visual Analogue Scale (VAS), Star Cancellation Test (SCT), Line Bisection Test (LBT), Picture Scanning Test (PST). Outcomes were assessed at baseline, and one week in between for each of the three conditions.	Mood and arousal as measured by the VAS significantly improved with pleasant music (p=0.03). The SCT and PST had significant improvement in the pleasant music condition (p=0.01, p=0.058); however, no significant effect of condition on LBT was found (p=0.59). During the visual exploration task, for the left-side of screen there was a significant effect of condition on percentage of target items reported (p=0.01), with pleasant music having the highest target items reported.
Caloric Vestibular Stimulation					
Sturt & Punt 2013 **UK**	N/A	18 patients with left hemispheric stroke (LHS, n=6), right hemispheric stroke without neglect (RHSN–, n=6), and right	Caloric vestibular stimulation (CVS) was administered to all	**Primary Outcomes:** SCT.	Baseline (pre-CVS) scores for the LHS and RHSN– groups did not indicate a deficit in

Pre-Post		hemispheric stroke with neglect confirmed by Start Cancellation Test (SCT) scores <51 (RHSN+, n=6).	subjects by dribbling 60 mL of cold water via a syringe into the contralateral ear for 60 seconds.	Outcomes were assessed at baseline, immediately, one hour and two hours post intervention.	visuospatial function; CVS had no impact on performance for these two groups. The mean SCT score for the RBD+ group was 20.5 pre-CVS and 23.5 post-CVS (p=0.17). One hour following CVS, the mean SCT score was 29, significantly improved from baseline score (p=0.05).
Fong et al. 2013 **China** **RCT**	CA: ☑ Blinding: Subject ☒ Assessor ☑ ITT: ☑	40 patients with sub-acute left hemiplegic stroke (experimental=24.3±18.5 days; control=22.3±12.0 days) and unilateral neglect.	Patients were randomized to one of two groups: 1) adornment of a wristwatch cueing device over the hemiplegic arm for 3 hr/d, 5 d/wk for 3 weeks, or 2) adornment of a sham device (control).	**Primary Outcomes:** Behavioural Inattention Test (BIT) [cancellation task, drawing task]**,** Fugl-Meyer Assessment (FMA) [upper limb, hand]**,** Functional Independence Measure (FIM), Functional Test for the Hemiplegic Upper Extremity (FTHUE). Outcomes were assessed at baseline and week 3 and 6.	The only significantly different outcome between the two groups was the BIT neglect drawing tasks, in which the experimental group performed better (p=0.034); [BIT cancellation: p=0.908, FIM: p=0.040, FTHUE: p=0.340, FMA upper limb: p=0.301, FIM hand: p=0.358]. The experimental group demonstrated a larger improvement in arm motor performance than the control group.
Electrical Stimulation					
Kim et al. 2013 **Korea** **RCT**	CA: ☑ Blinding: Patient ☑ Assessor ☒ ITT: ☑	27 subjects with visuospatial neglect (confirmed via Line Bisection Test) after acute stroke (approximately 15 days in duration).	Subjects were randomized to receive 10 sessions over 2 weeks of 1) low-frequency (1Hz) rTMS over the non-lesioned posterior parietal cortex (PPC), 2) high-frequency (10Hz) rTMS over the lesioned PPC, or 3) sham stimulation.	**Primary Outcomes:** Motor-Free Visual Perception Test (MFVPT) Line Bisection Test (LBT), Star Cancellation Test (SCT), Catherine Bergego Scale (CBS), Korean-Modified Barthel Index (K-MBI). Outcomes were assessed at baseline and post treatment.	ANOVA demonstrated that scores were significantly different on all outcome measures between the three groups (p=0.049). Post hoc analysis demonstrated that the improvement in LBT scores in the high-frequency rTMS group was statistically significant compared to those in the sham-stimulation group (high vs sham p=0.03, low vs sham p=0.09, high vs low p=0.58). The improvements in the K-MBI scores in the high-

					frequency and low-frequency rTMS groups were statistically significant compared to those in the sham stimulation group (high vs sham p<0.01. low vs sham p=0.02, high vs low p=0.75).
Sunwoo et al. 2013 **Korea** **RCT**	CA: ☑ Blinding: Patient ☑ Assessor ☑ ITT: ☑	10 chronic stroke patients, with a left unilateral visuospatial neglect.	Subjects were randomized into one of three groups: 1) dual-mode, anodal tDCS over the right posterior parietal cortex (PPC) and cathodal tDCS over the left PPC, 2) single-mode, anodal tDCS over the right PPC, or 3) sham tDCS. All sessions lasted 20 minutes.	**Primary Outcomes:** Line Bisection Test (LBT), Star Cancellation Test (SCT). Outcomes were assessed at baseline and immediately post treatment.	Significant improvements were observed on the LBT after both dual- and single-mode tDCS (p<0.05), but not after sham stimulation (p>0.05); dual tDCS had a stronger effect than single stimulation mode (p<0.05). No significant differences were noted in SCT scores (p>0.05).
Mirror Therapy					
Pandian et al. 2014 **India** **RCT**	CA: ☑ Blinding: Patient ☒ Assessor ☑ ITT: ☒	48 stroke patients with thalamic and parietal lobe lesions and unilateral neglect 48 hours post stroke.	Subjects were randomized into one of two groups: 1) mirror therapy (MT) group or 2) control (sham MT) group. All patients also received limb activation after MT or sham MT. Treatment sessions lasted 1-2 hours and were given once a day 5 days a week for 4 weeks.	**Primary Outcomes:** Star Cancellation Test (SCT), Line Bisection Test (LBT), Picture Identification Task (PIT). Outcomes were measured at 1, 3 and 6 months after baseline measurements.	Improvement was seen across all outcome measures (SCT, LBT and PIT) after 1 month (p<0.0001, p=0.002, p<0.0001, respectively), 3 months (p<0.0001, p=0.005. p<0.0001, respectively) and 6 months (p<0.0001, p=0.006, p<0.0001, respectively) in patients who received MT compared to the control group. MT is a simple treatment that improves unilateral neglect.
Dohle et al. 2009 **Germany** **RCT**	CA: ☑ Blinding: Patients ☑ Assessors ☑ ITT:☒	36 patients with severe hemiparesis as a result of their first-ever ischemic stroke. Participants were eligible for inclusion if they had a stroke occurring no more than 8 weeks prior to study inclusion and confined to the middle cerebral artery; Age: 25-80 yrs; able to follow therapy instructions and	All participants completed a standard therapy protocol requiring the execution of arm, hand, and finger postures in response to verbal instructions.	**Primary Outcomes:** Fugl-Meyer Test: 7 upper limb sub-scores. **Secondary Outcome:** Action Research Arm Test Functional	There was no significant therapy effect regarding motor function in any of the 3 motor sub-scores across all patients. MT participants had significant improvements in non-motor symptoms such as surface

		participate in 30-minute daily therapy sessions. Patients whom had previous strokes; major hemorrhagic changes; increased intracranial pressure; hemicraniectomy/orthopedic/rheumatologic or other diseases interfering with their ability to sit or move either upper limb were excluded from the study. A total of 48 participants met inclusion and exclusion criteria, however only 36 patients completed the study, 12 participants dropped out during the course of the study.	Participants were randomized to either a mirror therapy (MT) where they watched the mirror image of the unaffected arm as if it were the affected arm; or a control therapy (CT) where no mirror was present.	Independence Measure (FIM): first 13 items of the motor section. Neglect tests	sensibility (p=0.009) and neglect scores (p=0.005).
Rothgangel et al. 2011 **The Netherlands** **Systematic Review**	N/A	10 RCTs, 7 patient series, and 4 single-case studies (n=341) that evaluated the clinical aspects of mirror therapy (MT) interventions after stroke, phantom limb pain (PLP) and complex regional pain syndrome (CRPS). **Inclusion criteria:** Participants: aged > 18 years; MT given as long-term treatment (more than two interventions) either as the only therapy intervention or in combination with other types of treatment strategies.	Methodological quality of the studies was assessed using the Amsterdam-Maastricht Consensus List (AMCL).	**Stroke:** Measurements of activity level. **CRPS and PLP:** Pain intensity.	All 6 RCTs investigating the effects of MT as an additional therapy in stroke patients displayed similar positive results for improving arm function. In patients with CRPS type 1, MT alone or in combination with limb laterality recognition and graded motor imagery showed positive results in 4 RCTs for pain intensity. The two studies that investigated the effects of MT and graded motor imagery on PLP in patients following amputation of the upper/lower limb or brachial plexus avulsion found positive results regarding patient-specific functions, pain intensity, and number and duration of pain episodes.

Interventions for Motor Apraxia

Study/Type	Quality Rating	Sample Description	Method	Outcomes	Key Findings and Recommendations
West et al. 2008 **UK** **Systematic Review and Meta-Analysis (Cochrane Review)**	N/A	3 trials were identified for inclusion (n=132) Studies that included patients with conditions other than stroke were excluded unless >75% of the sample was post-stroke or subgroup analyses were reported. Included trials investigated strategy training vs. usual care (n=113), gesture training vs. conventional aphasia treatment (n=10), and transfer of training vs. a functional approach (n=9).	RCTs examining the effectiveness of interventions for post-stroke motor apraxia were identified using electronic and hand-searching techniques (as per Cochrane method). All types of Apraxia were considered except for speech/oral apraxia. Identified trials were rated for quality to assess risk of bias. Pooled analyses were conducted where possible using fixed-effects models. Peto odds ratios (OR) were calculated for binary outcomes whereas weighted mean differences (WMD) were calculated for continuous outcomes. Statistical heterogeneity was assessed using the I^2 statistic.	Primary outcome: Independence in ADLs (e.g., Barthel Index, Assessment of Motor and Process Skills, and the Functional Independence Measure). Secondary outcomes: Death, quality of life, ability to gesture/pantomime/use objects, mood, family/carer well-being, and adverse events. The primary endpoint was 6-month follow-up. Secondary endpoints were at the end of the intervention period and 12-month follow-up.	Change in Barthel Index score: 6-month follow-up: MD=0.17, 95% CI -1.41 to 1.75; p>0.05. Results from 1 trial included (n=83). At the end of therapy: MD=1.28, 95% CI 0.19 to 2.38; p=0.02. Results from 2 trials included (n=102). Death: OR=0.41, 95% CI 0.09 to 1.90, p>0.05. Results from 3 trials included (n=132). Ability to gesture, pantomime, use objects: Gesture training: MD=8.4, 95% CI -15.8 to 32.6, p>0.05. Results from 1 trial included (n=10). Use of objects: MD=1.2, 95% CI -3.2 to 5.6, p>0.05. Results from 1 trial included (n=10).

Glossary
RCT= Randomized Controlled Trial
N/A = Not Applicable
CA = Concealed Allocation
ITT = Intention to treat
OR = Odds Ratio
CI = Confidence Interval
IQR = Interquartile Range

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