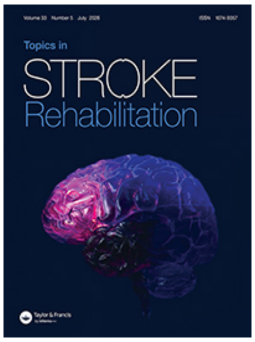

Topics in Stroke Rehabilitation

ISSN: 1074-9357 (Print) 1945-5119 (Online) Journal homepage: www.tandfonline.com/journals/ytsr20

Cognitive strategies for improving activity-level outcomes post stroke: an integrative review

Faye Tabone, Ibe Couwels, Rachel C. Stockley & Nele Demeyere

TOPICS IN STROKE REHABILITATION
https://doi.org/10.1080/10749357.2026.2684949

REVIEW ARTICLE

OPEN ACCESS | Check for updates

Cognitive strategies for improving activity-level outcomes post stroke: an integrative review

Faye Tabone[a], Ibe Couwels[b], Rachel C. Stockley[c], and Nele Demeyere[a]

[a]Nuffield Department of Clinical Neurosciences, University of Oxford, Oxford, UK; [b]Faculty of Psychology and Educational Sciences, Brain and Cognition Unit, KU Leuven, Leuven, Belgium; [c]Stroke Research Team, School of Nursing and Midwifery, University of Central Lancashire, Preston, UK

ABSTRACT

Purpose: This integrative review aimed to identify cognitive strategy interventions supporting rehabilitation engagement and activity-level outcomes for individuals with post-stroke cognitive impairments.

Materials and methods: Following Joanna Briggs Institute (JBI) methodology and PRISMA-ScR checklist, comprehensive searches were conducted in Embase, CINAHL, Scopus, MEDLINE, and PsycINFO. Two reviewers independently performed study selection and data extraction, using the TIDieR checklist and QuADS for quality assessment.

Results: From 35,250 articles screened, 40 studies met the inclusion criteria, half ($n = 20$) were randomised controlled trials. Interventions were delivered between 6 days and 9.5 years post-stroke. Cognitive strategies included 20 domain-specific, 12 mental practice, and 8 global approaches. Global approaches were most consistent, though applicability across cognitive impairment type remains unclear. Domain-specific strategies target impairment directly and aim for transfer to functional outcomes, while mental practice approaches may only be suitable for mildly impaired cognition. Across studies, 47 different primary outcome measures were reported, with the Functional Independence Measure and Barthel Index used the most, across 10 studies each.

Conclusions: Three cognitive strategy categories were identified. Outcome measures lacked consistency and there was a notable lack of stakeholder involvement. Future research should standardise interventions and outcome measures to enable systematic evidence synthesis and inform clinical guidelines.

ARTICLE HISTORY
Received 18 August 2025
Accepted 31 May 2026

KEYWORDS
Cognitive impairment; stroke rehabilitation; engagement; activity-level; cognitive strategy

Introduction

Almost every stroke survivor can be expected to experience cognitive impairments during the acute stage of recovery,[1] with impairment prevalences differing depending on the sample population and tools used.[2] Simultaneously, over 70% of people who survive a stroke also experience motor difficulties in upper and lower limbs.[3] Despite being treated independently, post-stroke cognitive and motor impairments are both comorbid and highly correlated.[4]

The prevalence of domain-specific cognitive deficits varies across the post-stroke timeline, with attention and praxis most commonly affected in the acute phase, and language, memory, and attention deficits predominating at 6 months post-stroke.[1] Identifying and addressing cognitive impairments early on is important, as stroke survivors with cognitive deficits show poorer physical recovery and functional outcomes, negatively impacting activities of daily living (ADLs).[5] The presence of cognitive deficits directly impact performance on motor tasks.[6] For example, executive functioning, important for planning, initiating and adapting goal-directed activities and is commonly impaired after stroke,[7] affects the performance of motor tasks of the upper limb and hand.[6] Additionally, brain-injured individuals struggle to switch between motor tasks when the demands on executive functioning are high.[8] Notably, deficits in executive functioning predict reduced engagement levels in rehabilitation.[9] Both executive functioning and memory are the two domains most

CONTACT Faye Tabone Faye.tabone@ndcn.ox.ac.uk Nuffield Department of Clinical Neurosciences, University of Oxford, John Radcliffe Hospital, Headington, Oxford OX3 9DU, UK

Supplemental data for this article can be accessed online at https://doi.org/10.1080/10749357.2026.2684949

consistently linked to motor learning and motor improvement, which are key elements of motor rehabilitation.[10,11]

Consequently, a stroke survivor with cognitive deficits is less likely to participate in rehabilitation due to either excessive cognitive load of training, disengagement, or both. This could contribute to the poorer recovery experienced by those with cognitive deficits.[5] Considering that most stroke survivors are impaired in at least one cognitive domain during the early critical window when most rehabilitation is applied[1,12] it is important to identify interventions that sought out to improve engagement and motor rehabilitation outcomes for stroke survivors with cognitive impairment. In response to this need, this integrative review aimed to map the current evidence of existing cognitive strategies used in physical rehabilitation after stroke and will be used to guide future research in developing similar interventions.

Purpose

We conducted an integrative review investigating existing interventions that use cognitive strategies to improve activity-level/engagement outcomes in stroke survivors with cognitive impairments. The main research questions were:

(1) What are the current cognitive interventions that aim to improve rehabilitation performance at the activity-level?
(2) Which outcome measures were used to assess the intervention?

Methods

Protocol

The protocol for this review was preregistered on the 28th of November 2024 and is available on OSF (*DOI 10.17605/OSF.IO/SP96E)*. The review was initially designed and conducted following the JBI methodology for scoping reviews[13] and the Preferred Reporting Items for Systematic Reviews and Meta-analyses extension for Scoping Review (PRISMA-ScR) checklist.[14] During the process of data synthesis and interpretation, the review evolved beyond evidence mapping to include a more analytical and interpretive synthesis of the literature, with greater emphasis on implications for future research and evidence-based rehabilitation practice. As such, the final review is more appropriately characterised as an integrative review.[15]

Search strategy

The search strategy aimed to identify relevant published studies. A preliminary search of MEDLINE (Ovid) was conducted with the facilitation of a university librarian. Keywords and index terms from the titles and abstracts of pertinent articles were analysed to create a comprehensive search strategy for use across relevant databases and information sources (see Supplementary Materials). The search strategy was reviewed and agreed upon by research team members (FT, ND, RCS). This search approach, incorporating all identified keywords and indexing terms, was tailored for the additional databases: Embase (Ovid), PsycINFO (Ovid), CINAHL, and Scopus.

Source of evidence selection

Following the search, all identified citations were collated and uploaded into Rayyan[16] and duplicates were removed. After a pilot test, the titles and abstracts were independently screened for relevance based on pre-specified inclusion and exclusion criteria by two researchers (FT and IC). Full texts of potentially relevant sources were retrieved and assessed in detail against these criteria. Any conflicts between the two researchers were resolved by consulting co-authors ND and RCS. Reasons for excluding sources at the full-text stage were documented and included in the review.

Inclusion criteria

The following inclusion criteria were formulated using the JBI Population Concept Context (PCC) framework.[13] Articles were considered for inclusion in this review if they met the following criteria:

Population

Adults (18 years and older) who had a clinical diagnosis of stroke of any severity, at any stage of their recovery were included. Articles had to focus on a population of stroke survivors with cognitive impairments. Studies that explicitly excluded this population were not considered, while those that did not report on cognitive impairments were still included. Articles including different types of acquired brain injuries were included if the stroke-specific data could be separated/ if stroke survivors made up at least 50% of the study population.

Concept

This review included studies that used cognitive strategies as interventions to improve rehabilitation performance at the activity-level[17] Cognitive interventions were defined as techniques targeting memory, language, attention, executive function, praxis, and number processing, and considered metacognitive strategies and imagery techniques. Primary outcome measures included engagement in therapy and rehabilitation outcomes at the activity-level.[17]

Context

This review included any geographical as well as clinical/community-based setting. It was limited to human-based studies and the English language, due to limitations in translation resources. Studies weren't limited by year of publication and therefore included articles published until 2025.

Types of sources

This integrative review included published peer-reviewed articles that used quantitative, qualitative, and mixed methods study designs. Descriptive observational studies like case series, individual case reports, and descriptive cross-sectional studies were included. Systematic and scoping reviews, text, commentaries, and opinion papers were not considered for inclusion, and their references were not searched for additional screening. The search included grey literature, limited to PhD theses and conference abstracts where full texts were accessible. Review articles were excluded to prevent duplication of information.

Data extraction

Data were extracted from papers included in the integrative review by one researcher (FT) and checked for correctness by another researcher (IC). Two tables were required for data extraction. One table included general extraction components such as study methodology, sample size and characteristics, inclusion and exclusion criteria, outcomes, and key findings (table S1). Another table incorporated the TiDieR checklist components: Why, What, Who Provided, How, Where, When, and How Much, and Tailoring[18] (table S2). Outcome measures and frequency of use were tabulated (Table 1).

Quality appraisal

The quality of the included articles was independently assessed by authors FT and IC using Quality Assessment with Diverse Studies (QuADS) tool.[65] Any disagreements that arose between the reviewers were resolved through discussion with the full researcher team. QuADS is a validated tool for assessing the quality of a heterogonous sample of articles. The tool comprises 13 criteria, each rated on a scale from 0 to 3, yielding a maximum possible score of 39. Notably, the developers of the QuADS tool advise against applying strict cutoff scores. Instead, they recommend a narrative approach to interpretation, focusing on the strengths and limitations of individual criteria. Using QuADS in this review will facilitate interpretation of the interventions in the included articles. The resulting scores can be seen alongside study characteristics in table S1.

Data analysis and presentation

The included articles were synthesised narratively to answer each of the review questions, accompanied by tabulated results with extracted information on each included study (table S1, S2 and Table 1). Search strategy and details of the quality appraisal can be found in the Supplementary materials.

Results

Study selection

A literature search was conducted on the 2nd of May 2025, which yielded 35,250 articles. After the removal of 8,982 duplicates, 26,268 articles were screened by title and abstract resulting in 190 articles for full text screening. After full text screening, 40 articles were included. Reasons for exclusion of full text can be seen in the PRISMA flowchart (Figure 1).

Study characteristics

Studies were published between 1992 and 2025. The mean age of the stroke survivors of the combined included studies was 60.19 years (SD = 10.09) and their time-post stroke ranged between 6 days and 9.5 years.

Of the 40 included articles, 8 were conducted in the USA, 5 in the U.K, 4 in Canada, 4 in Italy, 3 in India, 3 in the Netherlands, 2 in Sweden, 2 in Iran, 2 in Brazil,1 in China, 1 in Israel, 1 in Portugal, 1 in Korea, 1 in Thailand, 1 in Switzerland, 1 in Germany, 1 in both the USA and Canada. The study designs varied across articles. Twenty studies were randomized controlled trials (RCT), 8 were case studies, 7 were pilot studies and 5 were pre-post (Figure 2).

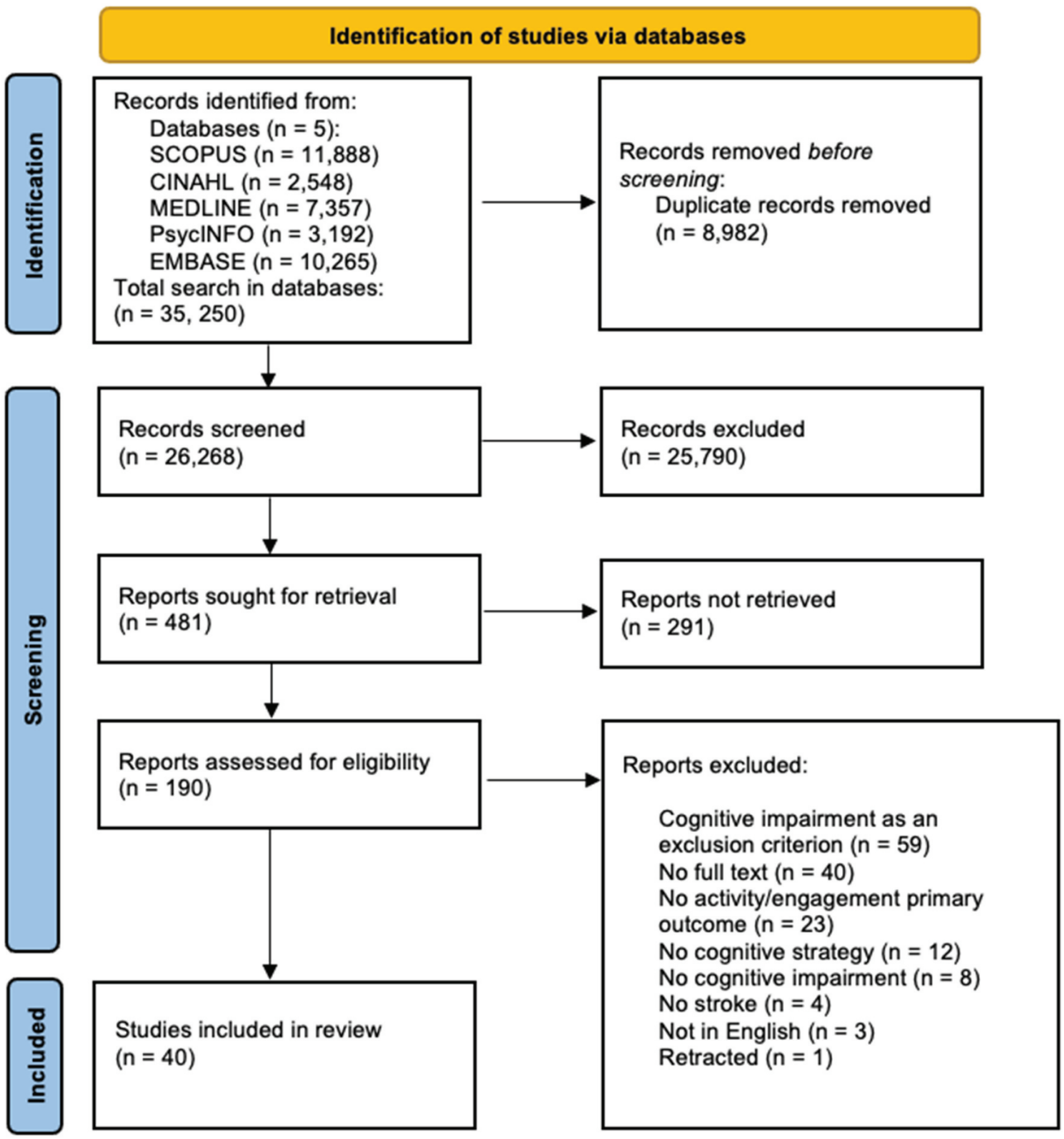

Figure 1. PRISMA flowchart documenting the screening process.

The characteristics of the 40 articles including overall quality appraisal score are summarised in table S1. Individual scores across the 13 criteria of the QuADS tool can be found in Appendix B of the Supplementary Materials. Scores ranged from 0 to 3, with higher scores indicating better quality. The overall scores ranged between 10[57] and 36[31] (out of 39). Notably, the highest rated criterion was *"format and content of data collection tool is appropriate"* ($M = 2.92$, SD = 0.39). In contrast, the lowest-rated criterion was *"evidence that stakeholders were considered in research design or conduct"* ($M = 0.61$, SD = 0.79).

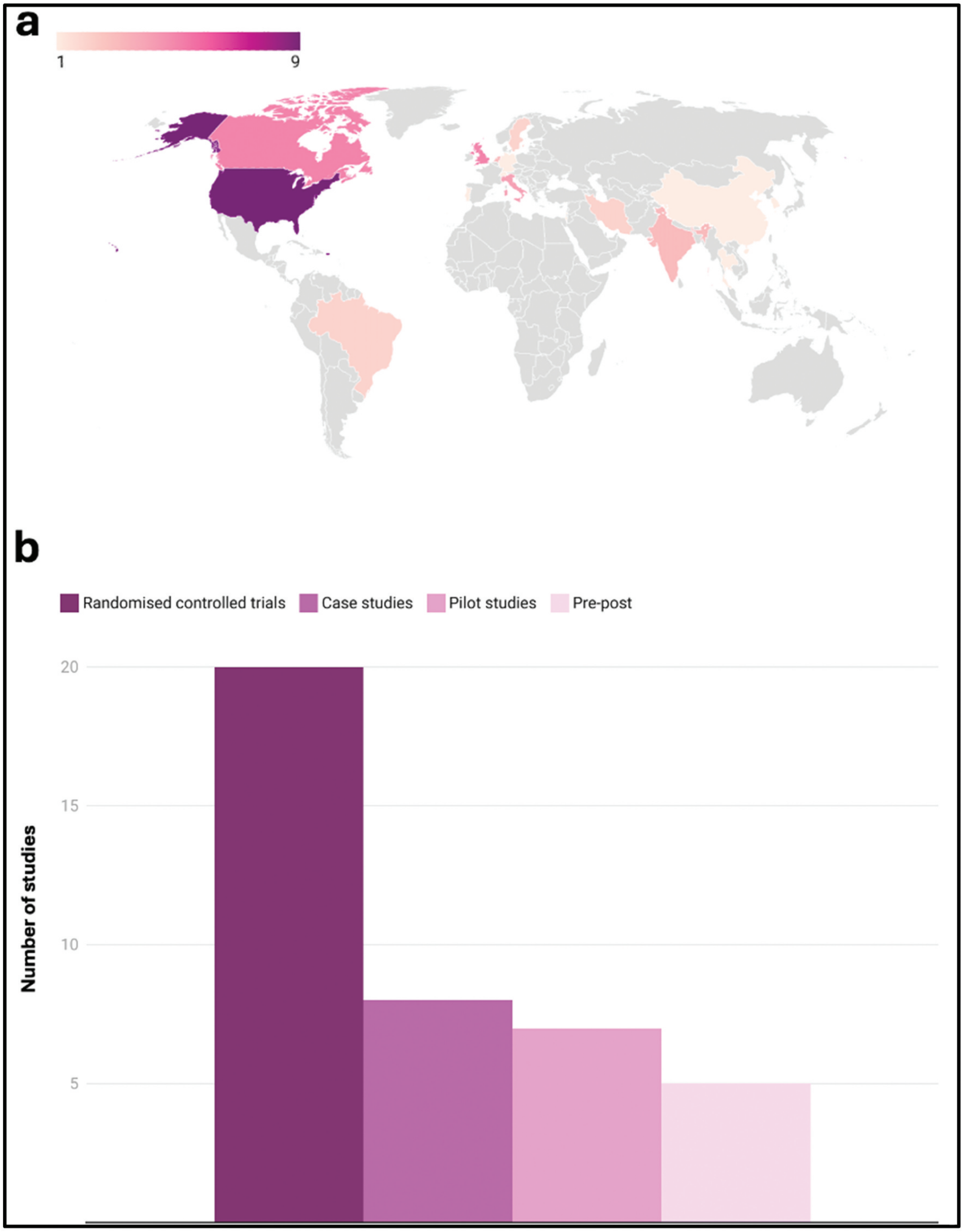

Figure 2. a) Study distribution by country b) study methodological approaches.

A detailed summary of the intervention components is summarised in table S2 using TiDiER checklist items, with a narrative summary addressing the review questions provided below.

What are the current cognitive Interventions?

The cognitive strategy interventions included in the studies in this integrative review can be considered to fall into three categories: domain-specific strategies, global cognitive strategies and mental practice interventions.

Domain-specific Strategies

Twenty of the forty included articles described interventions designed to target specific domain deficits[26,42,48,51,60,66–80] namely, attention[42,51,60,73] executive functioning (including working memory and cognitive flexibility)[67,74,79,80] language[66,68,76] and praxis.[26,69] Eight articles had a combination of different domain-specific cognitive training.[42,48,70–72,75,77,78]

The interventions within the included studies were provided by a range of allied healthcare professionals working in stroke rehabilitation: five were delivered by Occupational Therapists[26,51,69,70,73] three by Physiotherapists[70,72,79] four by (Neuro) psychologists[51,72,75,80] two by Speech and Language Therapists[66,76] one by nurses[70] four involved researchers[51,74,76,78] and two by therapy assistants.[73,76] In addition, four interventions were self-administered,[48,71,78,80] and five studies did not detail who delivered the intervention.[42,60,67,68,77] Many of the articles used software to deliver the intervention[48,66–68,71,72,75–80] including computerised training[48,66–68,75–80] and virtual reality.[71,72,77] Intervention details will be discussed based on domain below:

Attention

Only 10% (4/40) of the included studies targeted attention. Of these, three focussed on visuo-spatial neglect, each using different methods.[42,60,73,76] One study[42] ran a 13-week intervention started with left-sided multi-sensory cues (e.g. paper-pencil, ADL) later progressing to visuospatial analysis and perceptuomotor integration (e.g. using floor plans). A second study[73] used a 3-week intervention where the stroke survivors were asked to point to targets on a screen using prism glasses. The third study[60] used a strategy where images of lighthouses were placed on the neglected side, reminding stroke survivors to look out for lighthouses and reinforcing attention with verbal cues ("turn your head like a lighthouse") and tactile prompts (e.g. shoulder taps).

The fourth study[51] addressed general attention deficits by comparing Attention Process Training (APT) with Activity-based Attention Training (ABAT). APT involved structured, visual and/or auditory individualised tasks with increasing difficulty. Contrastingly, the ABAT focused on applying attention strategies to real-world tasks (e.g. cooking). Both interventions took 20 hours total over 4–6 weeks.

Executive function

Four of the forty included articles tested novel interventions for executive function.[67,74,79,80] Executive functions can be divided into three main components: inhibitory control allowing individuals to withhold impulses, working memory where you are able to hold and manipulate information in mind, and cognitive flexibility required for adapting to new situations.[81] One study[67] focused on working memory training, implementing an adaptive visuospatial and verbal working memory program using the software Cogmed QM, across 25 sessions. The training included weekly personalised feedback sessions. Two studies aimed to enhance cognitive flexibility[74,80] one[80] attempted this through the Braingymmer program, which consists of nine tasks targeting attention, memory, and reasoning, incorporating fast task-switching elements. In the other study[74] stroke survivors trained cognitive flexibility through set-shifting, cognitive control and problem-solving/planning tasks, whilst encouraging self-awareness and orientation through diary writing. A further study[79] combined working memory, interference control and inhibition, task-switching, and monitoring. In this study, a set of stimuli was displayed virtually, and different task rules were set depending on the executive function being measured across 10 1-h sessions.

Language

Only three (from 40) articles[66,68,76] described interventions used to improve post-stroke aphasia. The first article[66] focussed on improving functional communication in people with global aphasia. The intervention combined computer and paper-based tasks and took a non-linguistic approach, focussing on gestures and facial expressions. A speech and language therapist conducted the intervention for a maximum of 6 weeks.

Similarly, another article[76] explored the use of a computerised program in chronic stroke survivors with aphasia. The computerised speech and language therapy program (CSLT) consisted of repetitive practice of word-finding exercises which can be tailored to the individual by using personalised by working with family members to identify 100 words with personal relevance. This self-managed intervention lasted 6 months with 20–30-min daily sessions. Therapists visited once a month for encouragement.

Lastly, one study[68] conducted an 8-week intervention with 24 sessions total of 45 min of training using a PC program: Power-Afa software. This intervention was administered specifically for the treatment of chronic non-fluent aphasia and included a variety of tasks such as repetitive phonological tasks involving auditory skills in the comprehension of names and actions, a semantic task where the patient deciphers between semantic fields, written task using transcription exercises and morphological and syntactic tasks on different categories such as animals or colors.

Praxis

Two articles explored the use of strategy training in stroke survivors with apraxia.[26,69] Both provided the same intervention, with the later study being a follow-up study incorporating a control group.[69] The intervention consisted of goal setting between the patient and occupational therapist which will be used as the focus of the intervention. A patient with apraxia may have an issue with initiation, execution, or controlling/correcting the activity. The strategies will change according to which stage is affected. For example, if there was an issue with initiation, instructions were provided, if it was execution, verbal or physical assistance was provided, and finally if it was in control then feedback was given. The intervention differed in length depending on the article; 8[69] or 12 weeks.[26]

Combined training

Seven out of the 40 articles[42,48,70–72,75,77,78] explored domain-specific cognitive training targeting multiple deficits.

Three articles explored the effect of combined cognitive-motor training.[70–72] One article[70] used *NEUROvitalis HOME*, an 8-day, one-on-one program with 180 exercises at two difficulty levels, tailored to individual deficits. Participants were within 10 days post-stroke. Another study[71] investigated the use of "Reh@Task" Virtual reality (VR), set up in chronic stroke for 12 sessions stretched over 1 month, focussed on attention and memory. Another study delivered VR-based[72] cognitive and motor training (ClinicHEAD & HomeHEAD) addressing attention, memory, executive function, motor control (arm, trunk, gait), and ADLs like shaving and puzzles. In another study[77] cognitive workbooks and VR activities tailored to the individuals' cognitive deficits were conducted alongside aerobic exercises over 8 weeks and were compared to conventional cognitive rehabilitation.

Computerised cognitive-only training was conducted in three studies.[48,75,78] One article[75] combined tablet-based pointing tasks with prism adaptation glasses in stroke survivors with neglect, with serious games focussing on; sustained attention and monitoring, visual search, planning and switching, GO-NO GO tasks, working memory, and semantic associations over 10 sessions stretched over 2 weeks. Additionally, another study[48] used RehaCom software in sub-acute/chronic stroke, for 10 sessions over 5 weeks, with 20 modules targeting attention, memory, executive functioning and visuomotor skills. Similarly, the last study[78] used a digital platform with gamified tasks for attention, executive functions, processing speed and visuospatial construction over 1 month. It was self-administered with weekly feedback meetings.

Global cognitive interventions

In comparison to the domain-specific interventions described above, a global cognitive approach does not target specific domains but rather relies on multiple cognitive functions. Eight out of the 40 included articles describe these global cognitive interventions, specifically with the use of the Cognitive Orientation to Daily Occupational Performance (CO-OP) intervention.[82–89] CO-OP is a global cognitive strategy-based approach that is client-centered and aims to improve motor-based performance. It involves the use of problem-solving, guided by a therapist along with global cognitive strategies. Each of the eight articles used the CO-OP-inspired global strategy "Goal-Plan-Do-Check." Six studies described interventions provided by CO-OP-trained occupational therapists (OTs)[82,85–89] and two involved physiotherapists (PTs).[85,87] One intervention was delivered online[5,82] in rehabilitation units[85–89] but two studies did not specify a particular setting.[83,84] The different included articles differed in phase of intervention, 1 was in the acute[3,86] in the sub-acute[-2,85,87,88] in the chronic [83,84] phase, and 6 out of the 8 included articles reported cognitive impairments.[82–87]

Mental practice interventions

Mental practice refers to the mental rehearsal of physical movements without physical execution. It helps activate the same brain areas that a physical movement would, facilitating neuroplasticity.[90]

Twelve out of the 40 articles described interventions based on mental practice.[91–102]

Out of the 12 included studies, the intervention was delivered by physiotherapists[95,96] occupational therapists[99,102] self-administered[94,100] or unspecified.[91–93,98] The intervention length ranged from 2-[92] to 6 weeks.[95,99] The intervention focus varied from improving the upper limb[94,98,99] lower limb[93,95,99] and balance[97] to more general ADLs.[91,96,100]

Upper limb

The articles exploring mental practice effects on upper limb function. One article[94] compared the effectiveness of motor and visual imagery training programs alongside a motor training task. The motor imagery group rehearsed a token moving task using their affected hand, whilst the visual imagery group visualised previously seen images and was asked to recall each image. Similarly, another intervention[99] incorporated audio-guided Mental practice with repetitive-task specific practice. Another article[98] explored the effect of motor imagery between exercises, on trunk control.

Lower limb

Interventions that focussed on lower limb function included a telerehabilitation study[93] that required stroke survivors to attempt to execute a task based on patient-set goals and then incorporate motor imagery before re-executing. Another study[95] investigated the effects of an imagery intervention that incorporates both internal and external perspectives. A different approach was taken in one study[99] where an additional 15 min of motor imagery training was compared to 15 min of motor-dual task and 15 min of cognitive dual-task training, to improve gait and balance.

Mental practice in relation to and in combination with other rehabilitation methods

One study compared mental practice to domain-specific strategies.[96] Stroke survivors with hemi-spatial neglect were assigned to either a visual scanning or mental practice group. The visual scanning training group completed four tasks targeting extra-personal space and peri-personal space, while the mental practice group performed motor and visual imagery tasks (e.g. visualizing full-body movements, describing familiar spaces). Another article[91] incorporates motor imagery during spatial tasks alongside training of sensorimotor functions such as pressure awareness and distance perception.

Which outcome measures were used to assess the intervention?

In the forty articles included, 47 different primary outcomes measures were used to assess performance at the activity level, and engagement.

Between the variety of outcome measures used across studies; 10 focused on motor function (e.g. Action Research Arm Test (ARAT[20]) and the Motor Activity Log (MAL[28]), and another 10 evaluated balance, trunk control, and gait (e.g. Berg Balance Scale (BBS[29]) and Trunk Control Test (TCT[34]). Eleven studies included measures of activities of daily living (ADLs) and functional independence (e.g. Barthel Index (BI[39]) and Functional Independence Measure (FIM[40]). Three studies assessed occupational performance and workability, while another three evaluated rehabilitation engagement. Six measures addressed the cognitive impact on functioning, and four examined the subjective impact of stroke on daily life. Full details of all outcome measures are provided in Table 1.

The highly heterogeneous choices of assessment tools used across the included articles show a lack of consistency, despite aiming to measure similar goals. Only four assessment tools out of 47 appeared in three or more studies: FIM, BI, BBS

Table 1. Categories and frequency of use of outcome measures.

Domain	Outcome Measure	Number of Studies
Motor Function	Assessment of Motor and Process Skills (AMPS)[19]	2
	Action Research Arm Test (ARAT)[20]	1
	Chedoke Arm and Hand Activity (CAHAI)[21]	1
	Jebsen-Taylor Test of Hand Function (JTTHF)[22]	1
	Manual Function Test (MFT)[23]	1
	Wolf Motor Function Test (WMFT)[24]	1
	Motor Assessment Scale (MAS)[25]	1
	Motor functioning test[26]	1
	Fist closure frequency[27]	1
	Motor Activity Log (MAL)[28]	1
Balance, Trunk Control, and Gait	Berg Balance Scale (BBS)[29]	4
	Timed Up and Go Test (TUG)[30]	2
	Two-Minute Walk Test (2MWT)[31]	2
	Functional Gait Assessment Scale (FGAS)[32]	1
	Tinetti Gait and Balance Assessment[33]	1
	Trunk Control Test (TCT)[34]	1
	Trunk Impairment Scale[35]	1
	Postural Assessment Scale for Stroke Patients (PASS)[36]	1
	Activities-specific Balance Confidence Scale (ABC)[37]	1
	Gait and walking speed[38]	1
ADLs and Functional Independence	Barthel Index (BI)[39]	10
	Functional Independence Measure (FIM)[40]	10
	ADL observations[41]	1
	ADL measures[42]	1
	ADL questionnaire[26]	1
	Nottingham Extended ADL Scale (NEADL)[43]	1
	Lawton Instrumental ADL[44]	1
	Therapy Outcome Measure: activity (TOMs activity)[45]	1
	Modified Functional Limitations Profile (FLP)[46]	1
	Daily Living Task Assessment[47]	1
	Luton Index[48]	1
Occupational Performance and Workability	Assessment of Work Performance (AWP)[49]	1
	Workability Index (WAI)[50]	1
	Self-perceived occupational performance and satisfaction with performance[51]	1
Engagement in Rehabilitation	Hopkins Rehabilitation Engagement Scale[52]	1
	Utrecht Scale for Evaluation of Rehabilitation Participation[53]	1
	Pittsburgh Rehabilitation and Participation Scale[54]	1
Cognitive Impact on Functioning	Patient Reported Evaluation of Cognitive State (PRECiS)[55]	1
	ASHA Functional Assessment of Communication (ASHA-FACS)[56]	1
	Cognitive Failures Questionnaire (CFQ)[57]	1
	Dysexecutive Questionnaire (DEX)[58]	1
	Rating Scale of Attentional Behaviour (RSAB)[59]	1
	Route-finding task[60]	1
Subjective Impact of Stroke on Daily Life	Stroke Impact Scale (SIS)[61]	3
	EQ-5D-5 L[62]	1
	36-item Short Form Survey (SF36)[63]	1
	Fatigue Impact Scale (FIS)[64]	1

and the SIS, with the FIM and the BI being the most used measures, each featuring in 10 articles. Additionally, 47 primary outcomes between 40 included articles meant that some studies had multiple assessment tools selected as primary outcome measures. This ranged from studies combining objective (e.g. ARAT) and subjective (SIS)[61] measures, to assessing activity on different levels, e.g.: functional independence (FIM) and engagement to rehabilitation (Pittsburgh Rehabilitation and Participation Scale).[54]

Discussion

In this review, we aimed to identify and review existing cognitive strategy-based interventions aimed at improving engagement and/or activity outcomes in stroke rehabilitation to guide future intervention development and evaluation. In addition, a second research question focussed on describing which primary outcome measures were used to assess the interventions. Whilst cognitive and motor impairments are both highly prevalent and interact in stroke recovery, both are still often considered in isolation. This disconnect contributes to a limited understanding of the nature and impact of cognitive impairments on physical rehabilitation outcomes.

While there is substantial literature supporting the role of motor learning on motor recovery[103] the likely impact of cognitive impairment on re-learning and rehabilitation is frequently overlooked, as is the impact on engagement and participation in rehabilitation.[104] Consequently, the findings of this review provide a valuable contribution by highlighting cognitive strategy-based interventions found in the literature aimed at improving activity-level and engagement outcomes.

This integrative review identified 40 cognitive strategy-based interventions which were either targeting specific cognitive domain deficits (20), used a global approach to cognition (8) or focussed on mental practice as a cognitive tool in physical rehabilitation (12). Only half (20) of these studies used a randomised controlled trial (RCT) design.

Given, the diversity of study designs, the included articles were appraised using the QuADS tool.[65] The quality of the 40 included articles ranged from 10 to 36 (out of 39). The highest-rated criterion across the 40 included articles was *"format and content of data collection tool is appropriate,"* suggesting that, despite variability in the choice of outcome measures that this review identified, the tools used were generally well-aligned with each study's aims. In contrast, the lowest-rated criterion was *"evidence that stakeholders were considered in research design or conduct"*, highlighting a critical gap in patient and public involvement (PPI). This variability in quality scores reflects a key limitation of the integrative and scoping review methodology, which is to include diverse methodological approaches to map the breadth and nature of existing evidence, Therefore, to draw conclusions on the effectiveness of the interventions discussed in this review, large-scale RCT's with consistent outcome measures are needed.

The findings of this review are consistent with those of a prior critical review by McEwen et al. (2009),[105] which examined cognitive strategies aimed at enhancing motor skill acquisition. These strategies were also categorised as global, domain-specific, or mental practice approaches. While McEwen and colleagues focused on outcomes at the impairment level, the present review broadens the scope by emphasizing activity-level outcomes (as defined by the ICF)[17] and participant engagement. This shift contributes to a more comprehensive understanding of cognitive rehabilitation post-stroke. In addition, the present review was constrained to exclude studies which explicitly excluded patients with cognitive impairment.

Domain-specific

Domain-specific cognitive interventions dominated the included articles, with half (20) describing cognitive strategies based on attention, praxis, executive functioning and language, or a battery of domain-specific training. This targeted approach to specific cognitive deficits can also be referred to as "brain training" and with the rise of computerised programs, they have become a popular choice.[106] The strong association between domain-specific deficits and motor recovery, such as executive dysfunction and upper limb recovery[107] supports this domain-specific type of training program. It was beyond the scope of this review to consider the effectiveness of cognitive interventions on cognitive outcomes themselves. Instead, our focus in this review was on functional outcomes of interest such as ADL functioning, independence, motor functioning, and balance.

Whilst several studies reported positive outcomes, one common limitation noted by authors in the included studies, was the difficulty in demonstrating clear transfer of cognitive gains to broader functional activities or long-term outcomes.[108] For example, Dijkerman and colleagues (2004)[94] found that unsupervised motor imagery training improved performance on the trained task, but these improvements did not generalise to other motor functions or disability measures. Similarly, the included article by Soni et al. (2025)[78] noted no significant improvement in Lawton IADL scores despite cognitive gains. This highlights the "far transfer" problem in cognitive rehabilitation, where lab-based cognitive improvements may not easily translate to complex real-world behaviors.[109] The main drawback of domain-specific training on its own, is that it may fail to produce lasting results or to generalise improvements to other activities or settings.[110]

Global strategy

In contrast, eight of the included articles described a global cognitive strategy intervention, specifically CO-OP (Cognitive Orientation to daily Occupational Performance).[111] At its core, CO-OP uses a meta cognitive framework, adapted from Meichenbaum's Goal-Plan-Do-Check model[112] which teaches individuals to problem-solve and self-monitor. Therapists use guided discovery, a conversational approach involving prompts and coaching to help clients develop their own solutions, rather than providing direct instruction. This client-led process contrasts with conventional therapy, where the therapist identifies problems and teaches corrective strategies. The global strategy training interventions inspired by the CO-OP demonstrated the most consistency in terms of structure and delivery, in this review. Eight CO-OP-based included studies used the Canadian Occupational Performance Measure (COPM).[113] To identify self-selected goals, followed by approximately 10 sessions involving guided discovery, allowing the stroke survivors to identify their own strategies. Several additional CO-OP-based articles were identified in the search but were excluded as their primary outcome was the COPM, which did not align with the review's focus on broader activity and engagement measures.

Among the included CO-OP studies, meaningful improvements were reported in the FIM, SIS, and Engagement and Participation scale, whereas outcome measures such as the AMPS and ARAT did not show these same positive improvements. It is possible that since the CO-OP intervention targets ADLs of priority, self-reported measures like the SIS and independence measures will show more positive changes than motor level assessments. Five of the 8 CO-OP studies required participants to have cognitive impairments[82–84,86,87] with 4 specifically restricting inclusion to those with executive dysfunction.[82,83,86,87] Despite inconsistent inclusion criteria between the articles, (6 out of 8) studies show meaningful improvements in activity limitations and engagement. Arguably, given that stroke survivors often experience impairments across multiple cognitive domains[1] and that greater cognitive impairment is associated with lower perceived recovery[5] a global cognitive intervention approach like CO-OP may be particularly beneficial for this population. Nevertheless, the applicability within different types of cognitive impairment profiles is less clear. Research explicitly aimed at determining who this intervention is best suited to and whether participants with e.g. language impairments can be included are critical next steps.

Mental practice

The final 12 studies that utilised cognitive strategy-based interventions used mental practice, which involves the cognitive rehearsal of movements and fits in this review's description of a cognitive strategy. This strategy was utilised as an adjunct to conventional physical rehabilitation. Additionally, mental practice performance is likely to be associated with an individual's cognitive abilities, specifically working memory capacity.[114] This means that to successfully undertake mental practice, an individual would require intact cognition. However, despite being included as a cognitive strategy in this review, most mental practice studies (8 out of 12) did not specify participants' cognitive status and were therefore could not be excluded from this review. Only two studies identified the presence of cognitive impairments, one targeting individuals with general cognitive deficits[102] another focusing on participants with hemispatial neglect.[96] Consequently, it is likely that in practice, some people would not be able to use mental practice as part of physical rehabilitation, which challenges its ability to be used as a rehabilitative approach with cognitively impaired stroke survivors.

Outcome measures

From the 40 included studies, 47 different primary outcome measures that focussed on engagement and the activity-level were identified. Appropriately selecting outcome tools to detect and reflect the key domains affected by the intervention, is critical to describing effectiveness. The plethora of outcome tools found in this review highlight a disparity in identifying domains affected by interventionsmaking future systematic approaches (such as meta-analyses) to judging effectiveness difficult or impossible. This is particularly important as half (20) of the included studies were RCTs and so were explicitly conducted to generate evidence of effectiveness. The diversity of outcome tools used is exemplified by an included article by Zera et al (2022)[89] which incorporated objective measures of performance (AMPS) as well as self-report and a qualitative component, asking stroke survivors their point of view regarding the intervention. This mixed methods approach can provide more insight. For example, a comparative study[115] assessed the differences in the results of an objective measure (AMPS) with those of a qualitative measure (ADL interview) in the same cohort of stroke survivors. The findings revealed no significant relationship between the objective (AMPS) and subjective (ADL interview) assessments. This highlights the importance of adopting a more holistic approach, incorporating both objective standardised assessments and subjective measures; to provide more meaningful outcomes . However, study design and protocol constraints may not allow such a combined approach.

Future research

As noted previously, the lack of consistency in outcome measure choice, as well as the lack of high-quality RCTs, prevents the systematic evidence synthesis required to identify effectiveness and inform guidelines.A standardised approach to assessing activity-level outcomes and/or engagement to activities may enable this important future work which could, in turn, influence guidelines and practice recommendations.

Across the 40 included studies, the lowest rated criterion from the QuADS tool was *"evidence that stakeholders were considered in research design or conduct"*. The importance of PPI in healthcare research is well-established, with several frameworks advocating for its integration throughout the research process.[116–118] In particular, the Medical Research Council's (MRC)[119] guidance on developing complex interventions emphasises engaging stakeholders throughout intervention design. For interventions aimed at enhancing post-stroke activity and engagement, the perspectives of both recipients and service providers are essential and may help standardise the outcome measures chosen as most meaningful to stroke survivors, or most beneficial to allied healthcare professionals who evaluate activity-level performance and engagement in physical rehabilitation.

This gap in stakeholder involvement reflects a broader issue in stroke rehabilitation research, where individuals with co-occurring impairments such as cognitive deficits, fatigue, and comorbidities are frequently excluded from intervention studies.[120] For instance, a 2016 meta-analysis found that only 31% of 215 stroke rehabilitation RCTs reported on participants' cognitive status, and nearly half of those used this information to exclude individuals with cognitive impairments.[121] Similarly, in the present review, 59 articles were excluded for this reason (see Figure 1), and among the 40 included studies, 16 specifically excluded participants with aphasia or language difficulties even when the intervention focused on cognitive outcomes.

These non-inclusive research practices highlight a concerning limitation in the generalizability of findings and contributes toward an evidence-practice gap. Incorporating the involvement of lived experience into the design and conduct of stroke rehabilitation research could help address these disparities.In addition, many research funders are rightly promoting the inclusion of underrepresented patient populations to ensure that interventions reflect real-world complexity[122].

Given the heterogeneity of stroke-related impairments, future research should consider evaluating intervention effectiveness in relation to individual impairment profiles. This approach may offer a better understanding of for whom, and under what conditions, specific interventions are most effective thereby enhancing the applicability of findings in clinical practice.

Limitations

This review offers a narrative overview of several cognitive interventions following a stroke that had a focus on enhancing activity-levels and/or engagement. A notable limitation lies in the broad definition of cognitive strategies, which includes interventions like mental practice, which are considered cognitive in nature but not necessarily targetting cognitive impairment. Due to the broad definition, there is a lack of MeSH terms that capture concepts relating to cognitive strategies which presented a limitation. This may have contributed to challenges in retrieving relevant literature. Moreover, there remains a notable gap in the published research specifically addressing the use of cognitive strategies to target activity-level outcomes, highlighting an area in need of further investigation.

Conclusion

This review aimed to identify relevant interventions that incorporate cognitive strategies to improve rehabilitation outcomes in stroke survivors. The included articles evaluated a broad range of interventions that can be categorised into; global, domain-specific, or mental practice interventions and used 47 different outcome measures selected to assess activity and engagement. The findings also highlight a lack of stakeholder involvement and exclusion of cognitively impaired stroke survivors to physical rehabilitation research. Future research should prioritise the inclusion of stroke survivors with cognitive impairment, the use of consistent outcome measures and more comprehensive reporting of patient and public involvement (PPI).

Author contributions

CRediT: **Faye Tabone:** Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Visualization, Writing – original draft, Writing – review & editing; **Ibe Couwels:** Data curation, Formal analysis, Writing – review & editing; **Rachel C. Stockley:** Conceptualization, Investigation, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing; **Nele Demeyere:** Conceptualization, Investigation, Methodology, Supervision, Visualization, Writing – original draft, Writing – review & editing.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

FT is supported by a postgraduate fellowship funded by The Stroke Association [PF23\100006]. ND [Advanced Fellowship NIHR302224] is funded by the National Institute for Health Research (NIHR). RCS is funded by a UK Research and Innovation (UKRI) Future Leader Fellowship [MRT022434/1].

ORCID

Faye Tabone http://orcid.org/0009-0008-0119-1773
Ibe Couwels http://orcid.org/0009-0000-3995-7107
Rachel C. Stockley http://orcid.org/0000-0003-4441-6860
Nele Demeyere http://orcid.org/0000-0003-0416-5147

References

1. Milosevich ET, Moore MJ, Pendlebury ST, Demeyere N. Domain-specific cognitive impairment 6 months after stroke: the value of early cognitive screening. *Int J Stroke*. 2024;19(3):331–341. doi: 10.1177/17474930231205787.

2. El Husseini N, Katzan IL, Rost NS, et al. Cognitive impairment after ischemic and hemorrhagic stroke: a scientific statement from the American Heart Association/American Stroke Association. *Stroke*. 2023;54(6):e272–e291. doi: 10.1161/STR.0000000000000430.
3. Lawrence ES, Coshall C, Dundas R, et al. Estimates of the prevalence of acute stroke impairments and disability in a multiethnic population. *Stroke*. 2001;32(6):1279–1284. doi: 10.1161/01.str.32.6.1279.
4. Verstraeten S, Mark RE, Dieleman J, van Rijsbergen M, de Kort P, Sitskoorn MM. Motor impairment three months post stroke implies a corresponding cognitive deficit. *J Stroke Cerebrovasc Dis*. 2020;29(10):105119. doi: 10.1016/j.jstrokecerebrovasdis.2020.105119.
5. Bisogno AL, Franco Novelletto L, Zangrossi A, et al. The Oxford cognitive screen (OCS) as an acute predictor of long-term functional outcome in a prospective sample of stroke patients. *Cortex*. 2023;166:33–42. doi: 10.1016/j.cortex.2023.04.015.
6. Abgottspon S, Steiner L, Slavova N, Steinlin M, Grunt S, Everts R. Relationship between motor abilities and executive functions in patients after pediatric stroke. *Appl Neuropsychol Child*. 2022;11(4):618–628. doi: 10.1080/21622965.2021.1919111.
7. Koziol LF, Budding DE, Chidekel D. From movement to thought: executive function, embodied cognition, and the cerebellum. *Cerebellum*. 2012;11(2):505–525. doi: 10.1007/s12311-011-0321-y.
8. van Donkelaar P, Osternig L, Chou LS. Attentional and biomechanical deficits interact after mild traumatic brain injury. *Exerc Sport Sci Rev*. 2006;34(2):77–82. doi: 10.1249/00003677-200604000-00007.
9. Kringle EA, Terhorst L, Butters MA, Skidmore ER. Clinical predictors of engagement in inpatient rehabilitation among stroke survivors with cognitive deficits: an exploratory study. *J Int Neuropsychol Soc*. 2018;24(6):572–583. doi: 10.1017/S1355617718000085.
10. Lowder RJ, Jaywant A, Fridman CB, Toglia J, O'Dell MW. Cognitive impairment predicts engagement in inpatient stroke rehabilitation. *Int J Rehabil Res*. 2022;45(4):359–365. doi: 10.1097/MRR.0000000000000552.
11. Rajda CM, Desabrais K, Levin MF. Relationships between cognitive impairments and motor learning after stroke: a scoping review. *Neurorehabil Neural Repair*. 2025;39(2):142–156. doi: 10.1177/15459683241300458.
12. Dromerick AW, Geed S, Barth J, et al. Critical period after stroke study (CPASS): a phase II clinical trial testing an optimal time for motor recovery after stroke in humans. *Proc Natl Acad Sci USA*. 2021;118(39):e2026676118. doi: 10.1073/pnas.2026676118.
13. Peters MDJ, Marnie C, Tricco AC, et al. Updated methodological guidance for the conduct of scoping reviews. *JBI Evid Synth*. 2020;18(10):2119–2126. doi: 10.11124/JBIES-20-00167.
14. Tricco AC, Lillie E, Zarin W, et al. PRISMA extension for scoping reviews (PRISMA-ScR): checklist and explanation. *Ann Intern Med*. 2018;169(7):467–473. doi: 10.7326/M18-0850.
15. Souza MT, Silva MD, Carvalho RD. Integrative review: what is it? How to do it? *Einstein (Sao Paulo)*. 2010;8(1):102–106. doi: 10.1590/S1679-45082010RW1134.
16. Ouzzani M, Hammady H, Fedorowicz Z, Elmagarmid A. Rayyan—a web and mobile app for systematic reviews. *Syst Rev*. 2016;5(1):210. doi: 10.1186/s13643-016-0384-4.
17. World Health Organization. *International Classification of Functioning, Disability and Health: ICF*. Geneva: World Health Organization; 2001.
18. Hoffmann TC, Glasziou PP, Boutron I, et al. Better reporting of interventions: template for intervention description and replication (TIDieR) checklist and guide. *BMJ*. 2014;348(mar07 3):g1687. doi: 10.1136/bmj.g1687.
19. Fisher AG. *The Assessment of Motor and Process Skills (AMPS)*. 3rd ed. Fort Collins, Colorado, USA: Three Star Press; 1995.
20. Lyle RC. A performance test for assessment of upper limb function in physical rehabilitation treatment and research. *Int J Rehabil Res*. 1981;4(4):483–492. doi: 10.1097/00004356-198112000-00001.
21. Barreca S, Gowland CK, and Stratford P. Development of the Chedoke arm and hand activity inventory: theoretical constructs, item generation, and selection. *Top Stroke Rehabil*. 2004;11(4):31–42. doi: 10.1310/JU8P-UVK6-68VW-CF3W.
22. Jebsen RH, Taylor N, Trieschmann RB, Trotter MJ, Howard LA. An objective and standardized test of hand function. *Arch Phys Med Rehabil*. 1969;50(6):311–319.
23. Miyamoto S, Kondo T, Suzukamo Y, Michimata A, Izumi S. Reliability and validity of the manual function test in patients with stroke. *Am J Phys Med Rehabil*. 2009;88(3):247–255. doi: 10.1097/PHM.0b013e3181951133.
24. Wolf SL, Catlin PA, Ellis M, Archer AL, Morgan B, Piacentino A. Assessing Wolf motor function test as outcome measure for research in patients after stroke. *Stroke*. 2001;32(7):1635–1639. doi: 10.1161/01.str.32.7.1635.
25. Dean C, Mackey F. Motor assessment scale scores as a measure of rehabilitation outcome following stroke. *Aust J Physiother*. 1992;38(1):31–35. doi: 10.1016/S0004-9514(14)60548-1.
26. van Heugten CM, Dekker J, Deelman BG, van Dijk AJ, Stehmann-Saris JC, Kinebanian A. Outcome of strategy training in stroke patients with apraxia: a phase II study. *Clin Rehabil*. 1998;12(4):294–303. doi: 10.1191/026921598674468328.
27. Sunderland A, Tinson D, Bradley L, Hewer RL. Arm function after stroke. An evaluation of grip strength as a measure of recovery and a prognostic indicator.

J Neurol Neurosurg Psychiatry. 1989;52(11):1267–1272. doi: 10.1136/jnnp.52.11.1267.

28. van der Lee JH, Beckerman H, Knol DL, de Vet HC, Bouter LM. Clinimetric properties of the motor activity log for the assessment of arm use in hemiparetic patients. *Stroke*. 2004;35(6):1410–1414. doi: 10.1161/01.STR.0000126900.24964.7e.
29. Berg K. Measuring balance in the elderly: preliminary development of an instrument. *Physiother Can*. 1989;41(6):304–311. doi: 10.3138/ptc.41.6.304.
30. Shumway-Cook A, Brauer S, Woollacott M. Predicting the probability for falls in community-dwelling older adults using the timed up & go test. *Phys Ther*. 2000;80(9):896–903.
31. Butland RJ, Pang J, Gross ER, Woodcock AA, Geddes DM. Two-, six-, and 12-minute walking tests in respiratory disease. *Br Med J (Clin Res Ed)*. 1982;284(6329):1607–1608. doi: 10.1136/bmj.284.6329.1607.
32. Wrisley DM, Marchetti GF, Kuharsky DK, Whitney SL. Reliability, internal consistency, and validity of data obtained with the functional gait assessment. *Phys Ther*. 2004;84(10):906–918. doi: 10.1093/ptj/84.10.906.
33. Tinetti ME, Williams TF, Mayewski R. Fall risk index for elderly patients based on number of chronic disabilities. *Am J Med*. 1986;80(3):429–434. doi: 10.1016/0002-9343(86)90717-5.
34. Collin C, Wade D. Assessing motor impairment after stroke: a pilot reliability study. *J Neurol Neurosurg Psychiatry*. 1990;53(7):576–579. doi: 10.1136/jnnp.53.7.576.
35. Verheyden G, Nieuwboer A, Mertin J, Preger R, Kiekens C, De Weerdt W. The trunk impairment Scale: a new tool to measure motor impairment of the trunk after stroke. *Clin Rehabil*. 2004;18(3):326–334. doi: 10.1191/0269215504cr733oa.
36. Benaim C, Pérennou DA, Villy J, Rousseaux M, Pelissier JY. Validation of a standardized assessment of postural control in stroke patients: the postural assessment scale for stroke patients (PASS). *Stroke*. 1999;30(9):1862–1868. doi: 10.1161/01.str.30.9.1862.
37. Moiz JA, Bansal V, Noohu MM, et al. Activities-specific balance confidence scale for predicting future falls in Indian older adults. *Clin Interv Aging*. 2017;12:645–651. doi: 10.2147/CIA.S133523. Accessed April 10, 2017.
38. Mehmet H, Robinson SR, Yang AWH. Assessment of gait speed in older adults. *J Geriatr Phys Ther*. 2020;43(1):42–52. doi: 10.1519/JPT.0000000000000224.
39. Mahoney FI, Barthel DW. Functional evaluation: The Barthel index. *MD State Med J*. 1965;14:61–65. 14258950.
40. Keith RA, Granger CV, Hamilton BB, Sherwin FS. The functional independence measure: a new tool for rehabilitation. *Adv Clin Rehabil*. 1987;1:6–18. 3503663.
41. van Heugten CM, Dekker J, Deelman BG, Stehmann-Saris JC, Kinebanian A. Assessment of disabilities in stroke patients with apraxia: internal consistency and inter-observer reliability. *Occup Ther J Res*. 1999;19(1):55–73. doi: 10.1177/153944929901900104.
42. Hanlon RE, Dobkin BH, Hadler B, Ramirez S, Cheska Y. Neurorehabilitation following right thalamic infarct: effects of cognitive retraining on functional performance. *J Clin Exp Neuropsychol*. 1992;14(4):433–447. doi: 10.1080/01688639208402836.
43. Nouri F, Lincoln N. An extended activities of daily living scale for stroke patients. *Clin Rehabil*. 1987;1(4):301–305. doi: 10.1177/026921558700100409.
44. Lawton MP, Brody EM. Assessment of older people: self-maintaining and instrumental activities of daily living. *Gerontologist*. 1969;9(3):179–186.
45. Enderby PM, John A. Therapy outcome measures in speech and language therapy: comparing performance between different providers. *Int J Lang Commun Disord*. 1999;34(4):417–429. doi: 10.1080/136828299247360.
46. Hutchinson J, Hutchinson M. The functional limitations profile may be a valid, reliable and sensitive measure of disability in multiple sclerosis. *J Neurol*. 1995;242(10):650–657. doi: 10.1007/BF00866915.
47. Liu KP, Chan CC, Wong RS, et al. A randomized controlled trial of mental imagery augment generalization of learning in acute poststroke patients. *Stroke*. 2009;40(6):2222–2225. doi: 10.1161/STROKEAHA.108.540997.
48. Veisi-Pirkoohi S, Hassani-Abharian P, Kazemi R, Vaseghi S, Zarrindast MR, Nasehi M. Efficacy of RehaCom cognitive rehabilitation software in activities of daily living, attention and response control in chronic stroke patients. *J Clin Neurosci*. 2020;71:101–107. doi: 10.1016/j.jocn.2019.08.114.
49. Fan CW, Taylor RR, Ekbladh E, Hemmingsson H, Sandqvist J. Evaluating the psychometric properties of a clinical vocational rehabilitation outcome measurement: the Assessment of work performance (AWP). *OTJR (Thorofare NJ)*. 2013;33(3):125–133. doi: 10.3928/15394492-20130614-01.
50. Tuomi K, Ilmarinen J, Jahkola A, Katajarinne L, Tulkki A. *Work Ability Index*. 2nd ed. Helsinki: Finnish Institute of Occupational Health; 1998.
51. Sargénius Landahl K, Schult ML, Borg K, Bartfai A. Comparison of attention process training and activity-based attention training after acquired brain injury: a randomized controlled study. *J Rehabil Med*. October 28, 2021. doi: 10.2340/16501977-2875.
52. Kortte KB, Falk LD, Castillo RC, Johnson-Greene D, Wegener ST. The Hopkins Rehabilitation Engagement Rating Scale: development and psychometric properties. *Arch Phys Med Rehabil*. 2007;88(7):877–884. doi: 10.1016/j.apmr.2007.03.030.
53. de Graaf JA, Volkers EJ, Schepers VPM, Visser-Meily JMA, Post MWM. Validity of the Utrecht scale for evaluation of rehabilitation-participation restrictions scale in a hospital-based stroke population 3

months after stroke. *Top Stroke Rehabil*. 2022;29(7):516–525. doi: 10.1080/10749357.2021.1956047.
54. Lenze EJ, Munin MC, Quear T, et al. The Pittsburgh rehabilitation participation Scale: reliability and validity of a clinician-rated measure of participation in acute rehabilitation. *Arch Phys Med Rehabil*. 2004;85(3):380–384. doi: 10.1016/j.apmr.2003.06.001.
55. Patchick E, Vail A, Wood A, Bowen A. PRECiS (patient reported evaluation of cognitive State): psychometric evaluation of a new patient reported outcome measure of the impact of stroke. *Clin Rehabil*. 2016;30(12):1229–1241. doi: 10.1177/0269215515624480.
56. Frattali CM, Thompson CM, Holland AL, Wohl CB, Ferketic MM. The FACS of life ASHA facs–a functional outcome measure for adults. *ASHA*. 1995;37(4):40–46.
57. Broadbent DE, Cooper PF, FitzGerald P, Parkes KR. The cognitive failures questionnaire (CFQ) and its correlates. *Br J Clin Psychol*. 1982;21(1):1–16. doi: 10.1111/j.2044-8260.1982.tb01421.x.
58. Gerstorf D, Siedlecki KL, Tucker-Drob EM, Salthouse TA. Executive dysfunctions across adulthood: measurement properties and correlates of the DEX self-report questionnaire. *Neuropsychol Dev Cogn B Aging Neuropsychol Cogn*. 2008;15(4):424–445. doi: 10.1080/13825580701640374.
59. Ponsford J, Kinsella G. The use of a rating scale of attentional behaviour. *Neuropsychol Rehabil*. 1991;1(4):241–257. doi: 10.1080/09602019108402257.
60. Niemeier JP, Cifu DX, Kishore R. The lighthouse strategy: improving the functional status of patients with unilateral neglect after stroke and brain injury using a visual imagery intervention. *Top Stroke Rehabil*. 2001;8(2):10–18. doi: 10.1310/7UKK-HJ0F-GDWF-HHM8.
61. Mulder M, Nijland R. Stroke impact scale. *J Physiother*. 2016;62(2):117. doi: 10.1016/j.jphys.2016.02.002.
62. Herdman M, Gudex C, Lloyd A, et al. Development and preliminary testing of the new five-level version of EQ-5D (EQ-5D-5L). *Qual Life Res*. 2011;20(10):1727–1736. doi: 10.1007/s11136-011-9903-x.
63. Je W Jr, Sherbourne CD. The MOS 36-item short-form health survey (SF-36). I. Conceptual framework and item selection. *Med Care*. 1992;30(6):473–483.
64. Mathiowetz V. Test-retest reliability and convergent validity of the fatigue impact scale for persons with multiple sclerosis. *Am J Occup Ther*. 2003;57(4):389–395. doi: 10.5014/ajot.57.4.389.
65. Harrison R, Jones B, Gardner P, Lawton R. Quality assessment with diverse studies (QuADS): an appraisal tool for methodological and reporting quality in systematic reviews of mixed- or multi-method studies. *BMC Health Serv Res*. 2021;21(1). doi:10.1186/s12913-021-06122-y.
66. Adjei-Nicol S, Sacchett C, Beeke S. Evaluating the effect of a non-linguistic cognitive intervention on functional communication in global aphasia: a case series study. *Int J Lang Commun Disord*. 2025;60(1):e13155. doi: 10.1111/1460-6984.13155.
67. Björkdahl A, Akerlund E, Svensson S, Esbjörnsson E. A randomized study of computerized working memory training and effects on functioning in everyday life for patients with brain injury. *Brain Inj*. 2013;27(13–14):1658–1665. doi: 10.3109/02699052.2013.830196.
68. De Luca R, Aragona B, Leonardi S, et al. Computerized training in poststroke aphasia: what about the long-term effects? A randomized clinical trial. *J Stroke Cerebrovasc Dis*. 2018;27(8):2271–2276. doi: 10.1016/j.jstrokecerebrovasdis.2018.04.019.
69. Donkervoort M, Dekker J, Stehmann-Saris FC, Deelman BG. Efficacy of strategy training in left hemisphere stroke patients with apraxia: a randomized clinical trial. *Neuropsychol Rehabil*. 2010;11(5):549–566. doi: 10.1080/09602010143000093.
70. Eschweiler M, Bohr L, Kessler J, Fink GR, Kalbe E, Onur OA. Combined cognitive and motor training improves the outcome in the early phase after stroke and prevents a decline of executive functions: a pilot study. *NeuroRehabilitation*. 2021;48(1):97–108. doi: 10.3233/NRE-201583.
71. Faria AL, Cameirão MS, Couras JF, Aguiar JRO, Costa GM, Bermúdez I. Combined cognitive-motor rehabilitation in virtual reality improves motor outcomes in chronic stroke - a pilot study. *Front Psychol*. 2018;9:854. doi: 10.3389/fpsyg.2018.00854. Accessed May 30, 2018.
72. Jonsdottir J, Baglio F, Gindri P, et al. Virtual reality for motor and cognitive rehabilitation from clinic to home: a pilot feasibility and efficacy study for persons with chronic stroke. *Front Neurol*. 2021;12:601131. doi: 10.3389/fneur.2021.601131. Accessed April 7, 2021.
73. Longley V, Woodward-Nutt K, Turton AJ, et al. A study of prisms and therapy in attention loss after stroke (SPATIAL): a feasibility randomised controlled trial. *Clin Rehabil*. 2023;37(3):381–393. doi: 10.1177/02692155221134060.
74. Pornkhan M. The effectiveness of cognitive rehabilitation on improving cognitive functions and activities of daily living in patients with stroke. *Siriraj Med J*. 2021;73(4):236–244. doi: 10.33192/Smj.2021.31.
75. Oliveri M, Bagnato S, Rizzo S, Imbornone E, Turriziani P. Prism adaptation combined with serious games for improving visual-constructive abilities in stroke patients: randomized clinical trial. *Front Digit Health*. 2025;7:1425410. doi: 10.3389/fdgth.2025.1425410. Accessed February 21, 2025.
76. Palmer R, Dimairo M, Cooper C, et al. Self-managed, computerised speech and language therapy for patients with chronic aphasia post-stroke compared with usual care or attention control (big CACTUS): a multicentre, single-blinded, randomised controlled trial. *Lancet Neurol*. 2019;18(9):821–833. doi: 10.1016/S1474-4422(19)30192-9.

77. Park M, Ha Y. Effects of virtual reality-based cognitive rehabilitation in stroke patients: a randomized controlled trial. *Healthcare (Basel)*. 2023;11(21):2846. doi: 10.3390/healthcare11212846. Accessed October 29, 2023.
78. Soni AK, Kumar M, Kothari S. Efficacy of home based computerized adaptive cognitive training in patients with post stroke cognitive impairment: a randomized controlled trial. *Sci Rep*. 2025;15(1):1072. doi: 10.1038/s41598-025-85511-3. Accessed January 7, 2025.
79. Tarantino V, Burgio F, Toffano R, et al. Efficacy of a training on executive functions in potentiating rehabilitation effects in stroke patients. *Brain Sci*. 2021;11(8):1002. doi: 10.3390/brainsci11081002. Accessed July 29, 2021.
80. van de Ven RM, Murre JMJ, Buitenweg JIV, et al. The influence of computer-based cognitive flexibility training on subjective cognitive well-being after stroke: a multi-center randomized controlled trial. *PLOS ONE*. 2017;12(11):e0187582. doi: 10.1371/journal.pone.0187582. Accessed November 16, 2017.
81. Diamond A. Executive functions. *Annu Rev Psychol*. 2013;64(1):135–168. doi: 10.1146/annurev-psych-113011-143750.
82. Dawson DR, Anderson ND, Binns M, et al. Strategy-training post-stroke via tele-rehabilitation: a pilot randomized controlled trial. *Disabil Rehabil*. 2024;46(1):67–76. doi: 10.1080/09638288.2022.2154397.
83. Henshaw E, Polatajko H, McEwen S, Ryan JD, Baum CM. Cognitive approach to improving participation after stroke: two case studies. *Am J Occup Ther*. 2011;65(1):55–63. doi: 10.5014/ajot.2011.09010.
84. Linkewich E, Avery L, Rios J, McEwen SE. Minimal clinically important differences in functional independence after a knowledge translation intervention in stroke rehabilitation. *Arch Phys Med Rehabil*. 2020;101(4):587–591. doi: 10.1016/j.apmr.2019.10.185.
85. McEwen S, Cirone D, Lee B. Incorporating a cognitive strategy approach into an outpatient stroke physiotherapy programme: case report. *Physiother Can*. 2017;69(3):193–196. doi: 10.3138/ptc.2016-13.
86. Skidmore ER, Holm MB, Whyte EM, Dew MA, Dawson D, Becker JT. The feasibility of meta-cognitive strategy training in acute inpatient stroke rehabilitation: case report. *Neuropsychol Rehabil*. 2011;21(2):208–223. doi: 10.1080/09602011.2011.552559.
87. Skidmore ER, Butters M, Whyte E, Grattan E, Shen J, Terhorst L. Guided training relative to direct skill training for individuals with cognitive impairments after stroke: a pilot randomized trial. *Arch Phys Med Rehabil*. 2017;98(4):673–680. doi: 10.1016/j.apmr.2016.10.004.
88. Wolf TJ, Polatajko H, Baum C, et al. Combined cognitive-strategy and task-specific training affects cognition and upper-extremity function in subacute stroke: an exploratory randomized controlled trial. *Am J Occup Ther*. 2016;70(2):p70022900101–p700229001010. doi: 10.5014/ajot.2016.017293.
89. Zera SM, Preissner K, Fischer H, Stoffel A. Cognitive orientation to daily occupation group in the adult day rehabilitation setting: a feasibility study. *Br J Occup Ther*. 2022;85(1):14–22. doi: 10.1177/03080226211008713.
90. Braun SM, Beurskens AJ, Borm PJ, Schack T, Wade DT. The effects of mental practice in stroke rehabilitation: a systematic review. *Arch Phys Med Rehabil*. 2006;87(6):842–852. doi: 10.1016/j.apmr.2006.02.034.
91. Choi W. Effects of cognitive exercise therapy on upper extremity sensorimotor function and activities of daily living in patients with chronic stroke: a randomized controlled trial. *Healthcare (Basel)*. 2022;10(3):429. doi: 10.3390/healthcare10030429. Accessed February 24, 2022.
92. Green TM, Vas AK. Mental practice to reduce severe upper extremity hemiparesis: a feasibility pilot study. *OTJR Occup Ther J Res*. 2025;45(4):583–591. doi: 10.1177/15394492251319251.
93. Deutsch JE, Maidan I, Dickstein R. Patient-centered integrated motor imagery delivered in the home with telerehabilitation to improve walking after stroke. *Phys Ther*. 2012;92(8):1065–1077. doi: 10.2522/ptj.20110277.
94. Dijkerman HC, Ietswaart M, Johnston M, MacWalter RS. Does motor imagery training improve hand function in chronic stroke patients? A pilot study. *Clin Rehabil*. 2004;18(5):538–549. doi: 10.1191/0269215504cr769oa.
95. Dunsky A, Dickstein R, Ariav C, Deutsch J, Marcovitz E. Motor imagery practice in gait rehabilitation of chronic post-stroke hemiparesis: four case studies. *Int J Rehabil Res*. 2006;29(4):351–356. doi: 10.1097/MRR.0b013e328010f559.
96. Ferreira HP, Leite Lopes MA, Luiz RR, Cardoso L, André C. Is visual scanning better than mental practice in hemispatial neglect? Results from a pilot study. *Top Stroke Rehabil*. 2011;18(2):155–161. doi: 10.1310/tsr1802-155.
97. Hosseini SA, Fallahpour M, Sayadi M, Gharib M, Haghgoo H. The impact of mental practice on stroke patients' postural balance. *J Neurol Sci*. 2012;322(1–2):263–267. doi: 10.1016/j.jns.2012.07.030.
98. Kulkarni S, Sureshkumar T. Effect of motor imagery in improving trunk control among hemiparetic patients. *Indian J Physiother*. 2018;12(3):150–155. doi: 10.5958/0973-5674.2018.00062.X.
99. Mishra N. Comparison of effects of motor imagery, cognitive and motor dual task training on gait and balance of stroke survivors. *Indian J Occup Ther*. 2015;47(2):46–51.
100. Nilsen DM, Gillen G, DiRusso T, Gordon AM. Effect of imagery perspective on occupational performance after stroke: a randomized controlled trial. *Am J Occup Ther*. 2012;66(3):320–329. doi: 10.5014/ajot.2012.003475.

101. Santos-Couto-Paz CC, Teixeira-Salmela LF, Tierra-Criollo CJ. The addition of functional task-oriented mental practice to conventional physical therapy improves motor skills in daily functions after stroke. *Braz J Phys Ther*. 2013;17(6):564–571. doi: 10.1590/S1413-35552012005000123.
102. Youze H, Ting Y, Yaqi B, Tianshen X, Tiecheng W, Jingsong W. Computer aided self-regulation learning and cognitive training improve generalization ability of patients with poststroke cognitive impairment. *Sci Rep*. 2021;11(1):24200. doi: 10.1038/s41598-021-03620-1. Accessed December 17, 2021.
103. Cirstea CM, Ptito A, Levin MF. Feedback and cognition in arm motor skill reacquisition after stroke. *Stroke*. 2006;37(5):1237–1242. doi: 10.1161/01.STR.0000217417.89347.63.
104. VanGilder JL, Hooyman A, Peterson DS, Schaefer SY. Post-stroke cognitive impairments and responsiveness to motor rehabilitation: a review. *Curr Phys Med Rehabil Rep*. 2020;8(4):461–468. doi: 10.1007/s40141-020-00283-3.
105. McEwen SE, Huijbregts MP, Ryan JD, Polatajko HJ. Cognitive strategy use to enhance motor skill acquisition post-stroke: a critical review. *Brain Inj*. 2009;23(4):263–277. doi: 10.1080/02699050902788493.
106. van Heugten CM, Ponds RW, Kessels RP. Brain training: hype or hope? *Neuropsychol Rehabil*. 2016;26(5–6):639–644. doi: 10.1080/09602011.2016.1186101.
107. Mullick AA, Subramanian SK, Levin MF. Emerging evidence of the association between cognitive deficits and arm motor recovery after stroke: a meta-analysis. *Restor Neurol Neurosci*. 2015;33(3):389–403. doi: 10.3233/RNN-150510.
108. van de Ven RM, Murre JM, Veltman DJ, Schmand BA. Computer-based cognitive training for executive functions after stroke: a systematic review. *Front Hum Neurosci*. 2016;10:150. doi: 10.3389/fnhum.2016.00150 .
109. Sigmundsdottir L, Longley WA, Tate RL. Computerised cognitive training in acquired brain injury: a systematic review of outcomes using the International Classification of Functioning (ICF). *Neuropsychol Rehabil*. 2016;26(5–6):673–741. doi: 10.1080/09602011.2016.1140657.
110. Veerbeek JM, van Wegen E, van Peppen R, et al. What is the evidence for physical therapy poststroke? A systematic review and meta-analysis. *PLOS ONE*. 2014;9(2):e87987. doi: 10.1371/journal.pone.0087987. Accessed February 4, 2014.
111. McEwen SE, Polatajko HJ, Huijbregts MP, Ryan JD. Exploring a cognitive-based treatment approach to improve motor-based skill performance in chronic stroke: results of three single case experiments. *Brain Inj*. 2009;23(13–14):1041–1053. doi: 10.3109/02699050903421107.
112. Meichenbaum DH, Goodman J. Training impulsive children to talk to themselves: a means of developing self-control. *J Abnorm Psychol*. 1971;77(2):115–126. doi: 10.1037/h0030773.
113. Law M, Baptiste S, McColl M, Opzoomer A, Polatajko H, Pollock N. The Canadian occupational performance measure: an outcome measure for occupational therapy. *Can J Occup Ther*. 1990;57(2):82–87. doi: 10.1177/000841749005700207.
114. Malouin F, Belleville S, Richards CL, Desrosiers J, Doyon J. Working memory and mental practice outcomes after stroke. *Arch Phys Med Rehabil*. 2004;85(2):177–183. doi: 10.1016/s0003-9993(03)00771-8.
115. Nielsen KT, Wæhrens EE. Occupational therapy evaluation: use of self-report and/or observation? *Scand J Occup Ther*. 2015;22(1):13–23. doi: 10.3109/11038128.2014.961547.
116. Jackson T, Pinnock H, Liew SM, et al. Patient and public involvement in research: from tokenistic box ticking to valued team members. *BMC Med*. 2020;18(1):79. doi: 10.1186/s12916-020-01544-7. Accessed April 13, 2020.
117. Skovlund PC, Nielsen BK, Thaysen HV, et al. The impact of patient involvement in research: a case study of the planning, conduct and dissemination of a clinical, controlled trial. *Res Involv Engagem*. 2020;6(1):43. doi: 10.1186/s40900-020-00214-5. Accessed July 19, 2020.
118. Harrison M, Palmer R. Exploring patient and public involvement in stroke research: a qualitative study. *Disabil Rehabil*. 2015;37(23):2174–2183. doi: 10.3109/09638288.2014.1001525.
119. Skivington K, Matthews L, Simpson SA, et al. A new framework for developing and evaluating complex interventions: update of Medical Research Council guidance. *BMJ*. 2021;374:n2061. doi: 10.1136/bmj.n2061. Accessed September 30, 2021.
120. Nelson M, Singh H, Nie J, et al. Comparing stroke rehabilitation inpatients and clinical trials eligibility criteria: a secondary chart review analysis revealing that most patients could have been excluded from rehabilitation trials based on comorbidity status. *J Multimorb Comorb*. 2023;13:26335565231211668. doi: 10.1177/26335565231211668. Accessed November 1, 2023.
121. Lohse KR, Schaefer SY, Raikes AC, Boyd LA, Lang CE. Asking new questions with old data: The centralized open-access rehabilitation database for stroke. *Front Neurol*. 2016;7:153. doi: 10.3389/fneur.2016.00153. Accessed September 20, 2016.
122. National Institute for Health and Care Research (NIHR) Research Inclusion Strategy 2022–2027 https://www.nihr.ac.uk/about-us/who-we-are/research-inclusion/strategy-2022-27 cited 15 06 2026 (United Kingdom: National Institute for Health and Care Research)