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Rehabilitation approaches for visual disorders post-stroke: A systematic review in neurological physiotherapy

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ABSTRACT

Introduction: Visual disorders after stroke are common and may substantially impair reading, mobility, spatial orientation, activities of daily living, and quality of life. Although various rehabilitation strategies have been developed, the evidence remains heterogeneous across impairment subtypes and intervention modalities. This systematic review aimed to examine rehabilitation approaches for post-stroke visual disorders, identify the types of interventions used, and summarize findings relevant to neurological physiotherapy practice.

Methods: A systematic review was conducted following PRISMA principles. Literature searches were performed in PubMed/MEDLINE, ScienceDirect, ProQuest, and Google Scholar from inception to March 2026. Eligible studies involved patients with stroke presenting with visual disorders, including hemianopia, diplopia, visual neglect, and visual perceptual deficits, and evaluated neurological physiotherapy-based rehabilitation interventions. Due to heterogeneity in interventions, outcome measures, and study designs, the findings were synthesized narratively.

Results: A total of 1,022 records were identified, and 15 studies were included in the final review. Most included studies were randomized controlled trials published between 2008 and 2025, with sample sizes ranging from 12 to 158 participants. The most common disorder was homonymous hemianopia, while the main interventions included visual scanning training, visual exploration training, smooth pursuit training, vision restoration training, virtual reality-based rehabilitation, and stimulation-based approaches such as tDCS and TENS. Overall, rehabilitation interventions were generally associated with improvements in functional outcomes, including visual search, reading performance, neglect measures, activities of daily living, and vision-related quality of life. Although some multimodal interventions combining visual training with sensory or electrical stimulation showed promising results, the findings varied across studies and should be interpreted cautiously.

Conclusion: Rehabilitation approaches for post-stroke visual disorders may support improvements in functional performance and quality of life; however, the evidence remains heterogeneous across visual impairment subtypes, intervention modalities, and outcome measures. Early identification, accurate phenotyping, and individualized rehabilitation planning may help optimize neurological physiotherapy management, but further well-designed studies are needed to determine the most effective intervention strategies.

Keywords: neurological physiotherapy, stroke, visual disorders, visual rehabilitation.
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INTRODUCTION

Stroke is a major cause of death and long-term disability worldwide. In 2021, there were about 11.9 million new stroke cases, 93.8 million survivors, and 7.3 million deaths globally.[1] Stroke can lead to visual problems because brain damage may affect visual pathways, eye movement centers, attention, and perception. Patients may have reduced visual sharpness, field defects, eye movement issues, double vision, neglect, or trouble with visual perception.[2,3] New visual problems occur in up to 48% of acute stroke patients and 60% of survivors, with overall post-stroke visual impairment affecting about 75%.[4,5] These issues can seriously impact walking, reading, spatial awareness, daily activities, and quality of life.[6,7] As a result, post-stroke visual impairment is both a diagnostic and a key rehabilitation concern during recovery.

Visual problems after stroke are often missed during routine rehabilitation, even though many patients have issues like blurred or double vision, trouble reading, or difficulty moving around.[7,8] Some survivors also fail to report visual symptoms even when objective examinations indicate impairment, making it easy for visual problems to go unrecognized in the early stages of rehabilitation.[9,10] Healthcare professionals in stroke care also report barriers such as the lack of structured procedures, limited practical knowledge, and the low prioritization of visual assessment compared to other, more prominent impairments.[10,11] This under recognition is clinically important because untreated visual deficits may interfere with mobility training, balance, environmental exploration, task performance, and patient safety during rehabilitation.[6,7]

Recent European Stroke Organization guidelines have recommended visual screening in stroke patients, while the development of tools such as the VISA suggests that early identification can be facilitated by instruments designed for non-specialist stroke teams.[5,12] Accurate early detection is crucial as it will influence referral, selection of rehabilitation targets, and determination of appropriate interventions in neurological physiotherapy.[6,13]

Previous systematic reviews have addressed the management of post-stroke visual impairment in general, interventions for visual field defects, and interventions for perceptual impairments separately. Reported interventions include visual scanning training, prisms, compensatory strategies, optical aids, limb activation, and virtual reality, but the quality of evidence, sample size, and consistency of outcomes across studies vary widely.[4,14,15] This makes it difficult for clinicians to determine which rehabilitation approaches are most relevant for particular visual deficits and which outcomes are most meaningful for patient function. Moreover, many interventions used in post-stroke visual rehabilitation are inherently multidisciplinary.[5,16]

Approaches such as virtual reality, transcranial direct current stimulation, and vision restoration therapy may involve input from physiotherapy, occupational therapy, orthoptics, ophthalmology, neuropsychology, and broader rehabilitation teams. Therefore, in the context of this review, neurological physiotherapy-based rehabilitation refers not to interventions delivered exclusively by physiotherapists, but to rehabilitation approaches that are relevant to neurological physiotherapy assessment, treatment planning, and functional recovery goals within multidisciplinary stroke care.[4,5]

Given the high clinical burden of post-stroke visual impairment, its frequent under recognition, and the lack of a clinically oriented synthesis linking visual deficits to rehabilitation strategies and functional outcomes, a focused review is warranted.[2,7,14] This systematic review aims to summarize rehabilitation approaches used for post-stroke visual impairment and to evaluate their clinical relevance for neurological physiotherapy within multidisciplinary stroke rehabilitation.

METHODS

Protocol Registration

This systematic review was registered in the public registry (PROSPERO) with the ID number CRD420261371330 and the review was conducted in accordance with the PRISMA 2020 statement.

Eligibility Criteria

Studies were included if they met the following criteria:

A. Population: Human participants with a confirmed diagnosis of stroke (ischemic or hemorrhagic) presenting with post-stroke visual disorders, including hemianopia, diplopia, visual neglect, and visual perceptual deficits. Studies that included mixed neurological populations (e.g., stroke combined with traumatic brain injury or intracranial tumor) were retained only if: (a) stroke participants constituted the majority (>80%) of the sample, or (b) separate outcome data for stroke participants could be extracted. Such studies were considered relevant because visual deficits arising from different etiologies may share similar rehabilitation mechanisms, and excluding them would have substantially reduced the available evidence base.

B. Intervention: Neurological physiotherapy–based rehabilitation targeting visual impairments, including visual scanning training, prism adaptation, eye movement training, visual perceptual training, virtual reality–based rehabilitation, and other compensatory or restorative approaches. In the context of this review, "neurological physiotherapy–based" refers to interventions relevant to physiotherapy assessment, treatment planning, and functional recovery goals within multidisciplinary stroke care.

C. Comparator: Usual care, no intervention (baseline comparison), sham intervention, or alternative rehabilitation. Studies without a comparator (e.g., single-arm pre-post designs) were excluded to ensure interpretability of effect estimates.

D. Outcomes: Visual function, reduction of visual symptoms, activities of daily living, quality of life, or neurological functional outcomes.

E. Study design: Randomized controlled trials (RCTs), quasi-experimental studies, controlled clinical trials, and cohort studies published in English.

Exclusion criteria including: Visual disorders not attributable to stroke, non-rehabilitative interventions, lack of a comparator, case reports, reviews, conference abstracts, and non-English articles.

Search Strategy

A comprehensive literature search was conducted in PubMed/MEDLINE, ScienceDirect, ProQuest, and Google Scholar from database inception to March 2026. Reference lists of included studies and clinical trial registries were also searched. The search strategy combined Medical Subject Headings (MeSH) and free-text keywords using Boolean operators. Below are the main search strings applied to each database, adapted for syntax differences:

PubMed/MEDLINE:

("stroke"[MeSH] OR "cerebrovascular disorders"[MeSH] OR "poststroke"[tiab]) AND ("visual disorders"[MeSH] OR "hemianopia"[tiab] OR "diplopia"[tiab] OR "visual neglect"[tiab] OR "visual perception"[MeSH]) AND ("rehabilitation"[MeSH] OR "neurological physiotherapy"[tiab] OR "visual scanning"[tiab] OR "eye movements"[MeSH] OR "virtual reality"[MeSH] OR "transcranial direct current stimulation"[tiab] OR "TENS"[tiab]) AND ("randomized controlled trial"[pt] OR "controlled clinical trial"[pt] OR "cohort studies"[MeSH])

ScienceDirect, ProQuest, Google Scholar:

(stroke OR poststroke) AND (visual disorder OR hemianopia OR diplopia OR visual neglect OR visual perception)

AND (rehabilitation OR physiotherapy OR visual scanning OR eye movement OR virtual reality OR tDCS OR TENS) AND (trial OR randomized OR controlled OR cohort)

Filters applied included English language and human studies. No publication date restrictions were applied.

Study Selection and Data Extraction

Two independent reviewers screened titles, abstracts, and full-text articles against the eligibility criteria. At the start of the searching process, all retrieved records were exported to Mendeley Reference Manager (Elsevier, Amsterdam, Netherlands) for citation management and duplicate detection. Duplicate records were removed at the beginning of the search process using Mendeley's automatic duplicate identification feature (based on title, author, year, and journal), followed by manual verification by two reviewers to ensure accuracy. Disagreements were resolved by discussion or a third reviewer. Two reviewers independently extracted data using a standardized, pre-piloted form. Extracted data included study characteristics, participant demographics, intervention details, outcome measures, and main findings. Missing data were sought by contacting study authors.

Effect Estimate Extraction

For continuous outcomes, mean differences or standardized mean differences with 95% confidence intervals were extracted when reported. For dichotomous outcomes, risk ratios with 95% confidence intervals were extracted. Effect estimates were extracted from all included studies where available. Quantitative pooling (meta-analysis) was not performed due to substantial clinical and methodological heterogeneity across studies in terms of visual disorder subtypes, intervention protocols, outcome measures, and follow-up durations. This decision was made a priori and is explained transparently in the synthesis section.

Risk of Bias Assessment

Two independent reviewers assessed risk of bias using the Cochrane RoB 2 tool for randomized controlled trials (addressing bias arising from the randomization process, deviations from intended interventions, missing outcome data, measurement of the outcome, and selection of the reported result). For the non-randomized study , the ROBINS-I tool (Risk Of Bias In Non-randomized Studies of Interventions) was used, assessing bias due to confounding, selection of participants, classification of interventions, deviations from intended interventions, missing data, measurement of outcomes, and selection of reported results. Disagreements were resolved by discussion or a third reviewer. Terminology and domain descriptions are reported exactly as specified in each tool.

Data Synthesis and Analysis

A narrative synthesis was conducted due to anticipated heterogeneity. Results were tabulated and grouped by visual disorder and intervention category. Heterogeneity was explored narratively by comparing study characteristics, including time since stroke onset, intervention type and duration, and comparator type. Sensitivity analyses were performed by excluding high risk-of-bias studies to assess robustness of the narrative findings.

RESULTS

Data Searching

The study search was conducted in accordance with the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. In the identification stage, a total of 1,022 records were obtained from several databases, namely ScienceDirect (n = 237), PubMed (n = 366), ProQuest (n = 117), and Google Scholar (n = 302). Nine records were removed before screening, leaving 1,013 records for the screening stage. In the screening stage, all records were reviewed based on title and abstract, with 922 records eliminated because they did not meet the criteria, leaving 91 reports for full-text search, but 15 reports were not successfully retrieved. Furthermore, in the eligibility assessment stage, 76 reports were fully evaluated and 61 reports were excluded due to the lack of relevant comparators (n = 3), ineligible populations (n = 10), irrelevant data (n = 13), incomplete data (n = 4), review articles (n = 30), and study protocols (n = 1). Ultimately, 15 studies met the

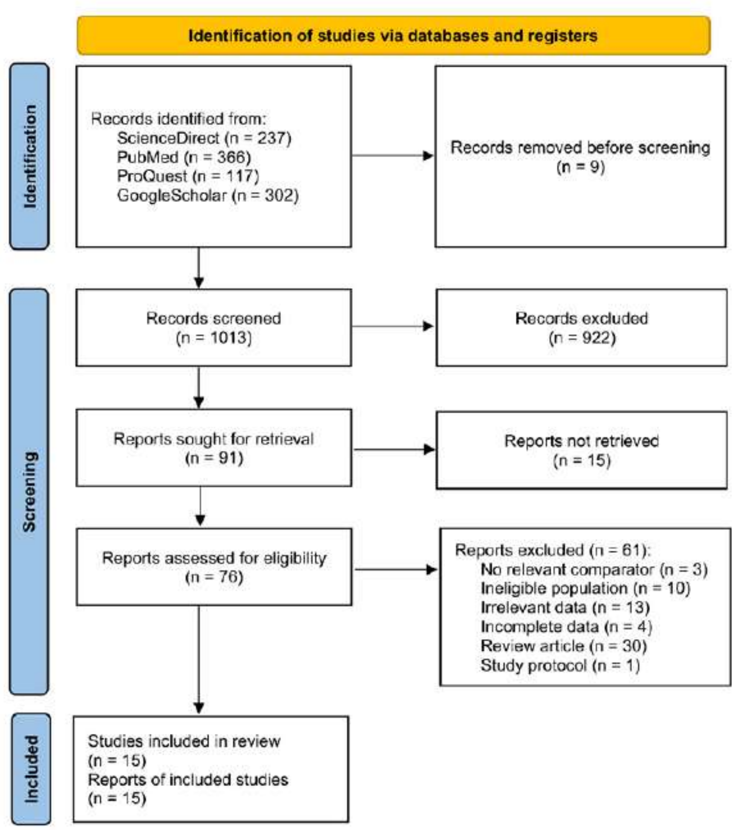

Figure 1. PRISMA Flowchart

inclusion criteria and were included in the systematic review, with the number of reports analyzed equaling the number of included studies (n = 15). (**Figure 1**).

Characteristics of the Included Studies

Based on the results of the literature search and selection, 15 studies were included in this systematic review. All included studies were published between 2008 and 2025. The majority of included studies used a randomized controlled trial (RCT) design, with one study using a non-randomized, open-label interventional design. Geographically, most studies were conducted in Europe, Australia, South Korea, and South Africa. The sample size in the included studies varied, ranging from 12 to 158 participants. The study populations primarily consisted of patients with stroke. The majority of visual impairments experienced by patients were homonymous hemianopia. Interventions were broadly categorized into compensatory and exploratory exercises (e.g., visual scanning training (VST)), technology and brain stimulation (e.g., virtual reality (VR), transcranial direct current stimulation (tDCS), and transcutaneous electrical nerve stimulation (TENS)), and restorative or sensorimotor training. The duration of interventions varied from short periods of 5 days to 12 weeks (**Table 1**).

The Outcomes and Main Findings of the Included Studies

The results of this systematic review indicate that visual rehabilitation interventions have varying impacts on patients' oculomotor function and perceptual abilities. Combined audio-visual training (AVT) has been shown to be significantly superior to standard visual training in improving visual exploration, reading speed, and objective parameters such as the number and amplitude of saccades.[20] The use of transcranial direct current stimulation (tDCS) combined with visual restorative training (VRT) has also demonstrated high effectiveness in visual field recovery compared to a control group.[18] However, several studies have noted that visual exploration or scanning training alone is often insufficient to improve reading or writing abilities without additional intervention.[28]

In the context of hemispatial neglect rehabilitation, the integration of multiple sensory modalities has shown more optimal results. Spatiomotor cueing (SPT) techniques provide more sustained improvements in visual measures and auditory midline normalization than standard scanning training.[21] Furthermore, contralesional hand stimulation combined with visual scanning training has been shown to be more effective than scanning alone.[26] The use of nerve stimulation such as TENS and OCS also provides clinical benefits on neglect tests and writing skills that persist in the short term,[28] although other studies have reported that the addition of TENS does not always provide statistically significant additional benefits.[29]

The impact of interventions on quality of life (QOL) and activities of daily living (ADL) has shown a positive trend in the majority of studies. Integrating saccadic eye movement training into visual scanning training significantly improved independence scores on the Barthel Index.[31] Subjective improvements in quality of life were also reflected in NEI VFQ-25 questionnaire scores,[19] as well as increased patient satisfaction as measured by the COPM, where patients felt safer during outdoor activities.[30] However, findings showed no significant difference between Visual Scanning Training (VST) and sham training over a 26-week observation period.[5] Overall, these data indicate that a multimodal rehabilitation approach, combining visual training with sensory or electrical stimulation, provides superior results compared to either therapy alone in improving functional deficits. Improvements in objective parameters such as saccadic speed and visual field size were positively correlated with independence in ADLs and patients' quality of life. Although there is variability in long-term effectiveness, the use of assistive technologies such as tDCS and the integration of multisensory exercises show great potential as a new standard in neuro-ophthalmological rehabilitation protocols to maximize neuroplasticity and patient functional recovery.

Risk of Bias

A risk of bias assessment using the Cochrane tool showed that all included studies had a low risk of bias in the blinding of outcome assessment domain, supporting internal validity, particularly in the primary outcome detection process. Most studies also demonstrated a low risk of bias in the selective reporting and other bias domains. However, methodological uncertainty existed in the selection domain, with several studies classified as having an unclear risk in random sequence generation and allocation concealment, primarily due to limited reporting of procedures in the original publications. Furthermore, performance bias related to the lack of blinding of participants and personnel was identified in a small number of studies, a common limitation of clinical interventions, particularly non-pharmacological ones. In addition to the Cochrane tool, a risk of bias assessment using the ROBINS-I tool was also conducted for non-randomized studies.

Individually, the studies by Polanowska et al. (2009), Rowe et al. (2025), and Seniów et al. (2015) demonstrated relatively high methodological quality with a low risk of bias in almost all assessed domains. In contrast, the study by Smaakjaer et al. (2018) demonstrated a high risk of bias, particularly in the selection and reporting domains. The ROBINS-I assessment confirmed that Smaakjaer et al. (2018) had a high risk of bias in the selection of participants and selection of the reported results domains, while maintaining a low risk in the classification of interventions, deviations from intended interventions, and measurement of outcomes. Methodological uncertainty was also noted in the confounding and missing data domains for this study. A high risk of performance bias was also identified in the study by Crotty et al. (2018) and Lane et al. (2010). Furthermore, issues related to incomplete outcome data (attrition bias) with unclear risk categories were found in several studies, such as Aimola et al. (2013) and Kerkhoff et al. (2013). Overall, despite variations in risk of bias across several methodological domains, the quality of evidence from the included studies was deemed sufficient to support the synthesis in this systematic review (**Figure 2, 3, and 4**).

Table 1. Characteristics of the Included Studies

Author (Year)	Country	Study Design	Sample Size (n)	Population	Type of Visual Disorder	Intervention	Comparator	Duration
Aimola et al. (2013)[17]	UK	RCT	70	Mix neurological (Ischemic stroke, haemorrhage, TBI, tumour)	Homonymous hemianopia or quadrantanopia	Home-based Reading & Exploration (R-E) training (unsupervised)	Control (attention-based training)	~5 weeks (35 hours)
Alber et al. (2016)[18]	Germany	RCT (Pilot study)	14	Stroke (Posterior cerebral artery stroke)	Homonymous Hemianopia	tDCS combined with Vision Restoration Training (VRT)	Standard rehabilitation	10 sessions (20 minutes each day)
Crotty et al. (2018)[19]	Australia	RCT (single-blind)	24	Not specified	Homonymous hemianopia	Standardized scanning + mobility program (Neuro Vision Tech)	Individualized therapy (usual care)	7 weeks (21 sessions)
Keller & Lefin-Rank (2010)[20]	Germany	RCT	20	Mix neurological (Ischemic/ haemorrhagic stroke, tumour, TBI)	Hemianopia or quadrantanopia	Audiovisual exploration training (AVT)	Visual exploration training (VT)	3 weeks (20 sessions)
Kerkhoff et al. (2013)[21]	Germany	RCT	50	Stroke	Auditory and visual neglect	Smooth pursuit eye movement training (SPT)	Visual scanning therapy (VST)	5 consecutive daily sessions (5 hours total) with 2-week follow-up
Lane et al. (2010)[22]	UK	RCT	42	Mix neurological (Ischemic stroke, haemorrhage, TBI)	Homonymous visual field defects (HVFD)	Group A: Visual exploration training. Group B: Attention training + exploration training.	Between-group comparison (exploration vs attention)	~4 weeks (15 sessions)
Luukkainen-Markkula et al. (2009)[23]	Finland	RCT	12	Not specified	Hemi spatial neglect	Arm activation training	Visual scanning training	3 weeks with 6-month follow-up
Mödden et al. (2012)[24]	Germany	RCT	45	Stroke (Posterior cerebral artery stroke)	Homonymous hemianopia / visual field defect	Restorative computerized training (RT) or compensatory therapy (CT)	Standard occupational therapy (OT)	15 sessions over 3 weeks

Table 1. Characteristics of the Included Studies (continued)

Author (Year)	Country	Study Design	Sample Size (n)	Population	Type of Visual Disorder	Intervention	Comparator	Duration
Namgung et al. (2024)[25]	South Korea	RCT	75	Stroke	Homonymous hemianopia or quadrantanopia	Nunap Vision (NV): virtual reality-based visual perceptual learning targeting the defective field; orientation, rotation, and depth discrimination training via VR head-mounted display, 384 trials/day, 5 days/week	Nunap Vision-Control (NV-C): matched central field training with smaller peripheral stimuli, delivered at the intact/central field as active control	12 weeks
Polanowska et al. (2009)[26]	Poland	RCT	40	Stroke (First right hemisphere stroke)	Left visuo-spatial neglect	Left-hand electrical/somatosensory stimulation combined with visual scanning training	Sham stimulation combined with visual scanning training	1 month-long rehabilitation programme
Rowe et al. (2025)[27]	UK	Double-blind RCT	158	Not specified	Homonymous hemianopia (partial or complete)	Paper-based visual scanning training (VST)	Sham training (slow tracking eye movements)	6 weeks (min 20 hours)
Schröder et al. (2008)[28]	Germany	RCT	30	Stroke (Acute unilateral right hemisphere cerebrovascular accident)	Visual neglect	Exploration training combined with TENS or optokinetic stimulation (OKS)	Standard exploration training alone	20 sessions over 4 weeks with 1-week follow-up
Seniów et al. (2015)[29]	Poland	RCT	29	Stroke (Right hemispheric stroke)	Left hemi spatial neglect	Active TENS to the left hand during conventional visual scanning training (VST)	Sham TENS during conventional visual scanning training (VST)	15 sessions over 3 weeks
Smaakjaer et al. (2018)[30]	Denmark	Interventional open-label (non-randomized)	24	Stroke (Ischemic or haemorrhagic)	Homonymous hemianopia alone or with oculomotor dysfunction	Therapist-assisted vision therapy (weekly sessions + daily home training)	None (baseline comparison)	12 weeks
van Wyk et al. (2014)[31]	South Africa	RCT	24	Stroke (Ischemic or haemorrhagic)	Unilateral spatial neglect	Saccadic eye movement training with visual scanning exercises integrated with task-specific physiotherapy activities	Task-specific activities alone	4-week intervention period

Table 2. The Outcomes and Main Findings of the Included Studies

Author (Year)	Outcome Measures	Main Findings
Aimola et al. (2013)[17]	Primary: Visual search ("find-the-number" RT), reading speed. Secondary: Tasks simulating ADL (hazard perception, obstacle avoidance, visuomotor search), attention tasks (SART, TEA), QOL questionnaires (VFQ-25, VIQ).	R-E training significantly improved primary outcomes (search & reading) vs control. Subjective QOL improved, but no objective gain on simulated ADL tasks. Home-based training was feasible with relatively low therapist support time. [Statistically Significant]
Alber et al. (2016)[18]	High-resolution perimetry (Absolute/Relative defects), Near vision, Reading speed.	Compared to controls (10.74 ± 8.86), recovery was considerably higher (p<.05) in tDCS/VRT patients (36.73 ± 37.0%). Significant reduction in relative defects in the tDCS/VRT group compared to the control group. [Statistically Significant]
Crotty et al. (2018)[19]	Primary: Mobility Assessment Course (MAC). Secondary: Visual Scanning Assessment (VSA), Pepper VSRT (reading), NEI VFQ-25, VA LV VFQ 48, MPAI, BIT.	No significant difference in primary outcome (scanning while walking) at 7 weeks or 3 months. Standardized group showed significant improvement in QOL (NEI VFQ-25 total & dependency sub-score) at 3 months. [Mixed findings]
Keller & Lefin-Rank (2010)[20]	Visual exploration test (LED detection), reading time, search task (object detection), activities of daily living (questionnaire), EOG (number & amplitude of saccades).	Both groups improved, but AVT was significantly superior to VT on all outcomes (exploration, reading, search time, ADL, saccade number & amplitude). [Statistically Significant]
Kerkhoff et al. (2013)[21]	Digit cancellation; line bisection; paragraph reading; auditory midline	SPT produced significant and lasting improvements in all visual measures and normalized auditory midline, whereas VST did not significantly change visual or auditory neglect. [Statistically Significant]
Lane et al. (2010)[22]	Perimetry (Tubingen), visual search ("find-the-number"), projected search, visuomotor search (block task), reading speed, visual impairments questionnaire.	Both training types improved most outcomes. Exploration training was not superior to attention training, except for a specific computer-based search task ("find-the-number"). Neither training improved reading. [Statistically Significant]
Luukkainen-Markkula et al. (2009)[23]	Behavioural Inattention Test (BIT); Catherine Bergego Scale (CBS); motor measures	Both groups improved. Arm activation training appeared beneficial even without supplementary visual neglect rehabilitation, while visual scanning training also improved neglect by follow-up. [Descriptive]
Mödden et al. (2012)[24]	Visual field expansion; visual search performance; reading performance; visual conjunction search; alertness; Barthel Index	Compared with OT, CT improved visual search performance; RT did not produce larger visual field expansion. CT improved all defined outcome parameters and may be the preferred intervention during inpatient rehabilitation. [Clinically meaningful]
Namgung et al. (2024)[25]	Primary: improved visual area on Humphrey visual field (HVF), defined as luminance detection sensitivity increase ≥6 dB in defective hemifield or whole field. Secondary: changes in mean total deviation (MTD) scores on HVF	Both NV and NV-C produced clinically meaningful improvement in visual area in the defective hemifield and whole field, but there were no significant between-group differences. [Clinically meaningful]
Polanowska et al. (2009)[26]	Cancellation tests; letter-reading task	After the month-long rehabilitation period, the experimental group improved significantly more than the control group. Contralesional hand stimulation combined with visual scanning was more effective than scanning training alone. [Statistically Significant]
Rowe et al. (2025)[27]	Primary: NEI VFQ-25 at 26 weeks. Secondary: NEADL, EQ-5D-5L, BIVI-IQ, visual field (Esterman), visual scanning performance (speed/accuracy), AEs.	Both groups improved on all primary and secondary outcomes. No significant difference between VST and sham training for any outcome measure at 26 weeks. AEs were mild (e.g., eye strain). [Descriptive]
Schröder et al. (2008)[28]	Standard neglect tests; reading performance; writing performance	Exploration training alone did not improve neglect tests or everyday reading/writing. TENS and OKS produced significant improvements, with reading and writing benefits maintained 1 week later. [Mixed findings]
Seniów et al. (2015)[29]	Psychometric tests of hemispatial neglect	Adding TENS to visual scanning training did not produce a significant additional benefit compared with sham stimulation. [Not Statistically Significant]
Smaakjaer et al. (2018)[30]	Primary: Canadian Occupational Performance Measure (COPM). Secondary: Groffman tracing test, reading speed, peripheral awareness (marker detection), MFI-20, MoCA, Rivermead memory test.	Significant improvements in COPM (satisfaction & performance), Groffman test, reading speed, and peripheral awareness. Patients felt safer in traffic/outdoors. [Statistically Significant]
van Wyk et al. (2014)[31]	King-Devick Test; Star Cancellation Test; Barthel Index	Integrated saccadic eye movement training with visual scanning exercises significantly improved neglect and activities of daily living compared with task-specific activities alone. [Statistically Significant]

DISCUSSION

This systematic review shows that post-stroke visual rehabilitation remains a clinically important but methodologically heterogeneous field, with more consistent evidence for improvement in functional performance than for true neurobiological restoration. Visual impairment after stroke is common, and its clinical relevance is substantial because these deficits may interfere with reading, visual exploration, mobility, confidence, and quality of life. At the same time, spatial neglect remains a frequent and disabling complication, particularly after right hemispheric stroke.[32,33] Across the included studies, the most consistent benefits were observed in functional outcomes such as visual search efficiency, reading performance, mobility-related confidence, and vision-related quality of life, whereas evidence for clear recovery of the damaged visual field was less consistent.[33,34]

An important interpretation of these findings is that the apparent effect of rehabilitation depends strongly on the outcome being measured. Studies of compensatory rehabilitation, particularly visual scanning-based paradigms, have repeatedly shown clinically meaningful gains in exploration behavior and daily task performance. However, these findings should be interpreted cautiously.[35,36] However, the interpretation of these gains has become more cautious after the SEARCH trial by Rowe et al. (2025), a rigorous multicenter randomized study in which both structured visual scanning training and sham slow-tracking training improved outcomes, yet no significant between-group difference was found at the primary endpoint.[37] This suggests that some of the improvement reported in earlier studies may reflect non-specific therapeutic engagement, repeated practice, expectancy effects, or spontaneous recovery, rather than a specific effect of scanning training alone.[32]

By contrast, restorative approaches remain biologically attractive but clinically unresolved. Interventions such as vision restoration therapy, computerized border-zone stimulation, and high-intensity virtual reality-based perceptual learning are grounded in the premise that repeated stimulation may reactivate partially spared

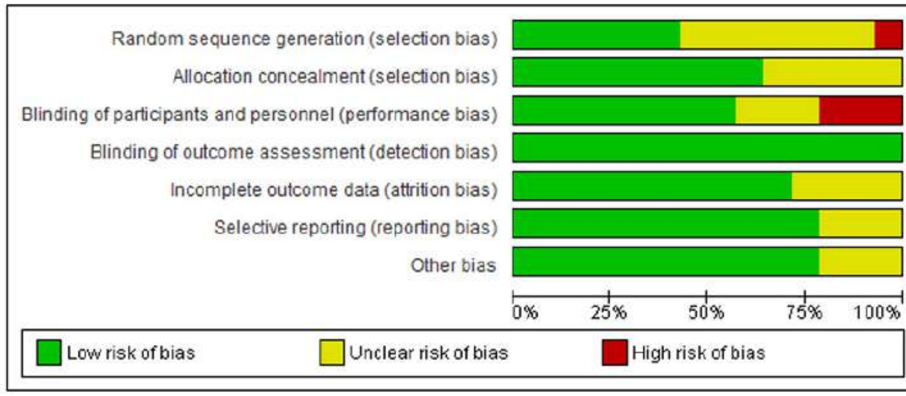

Figure 2. Risk of bias graph (Cochrane RoB 2 tool for RCTs)

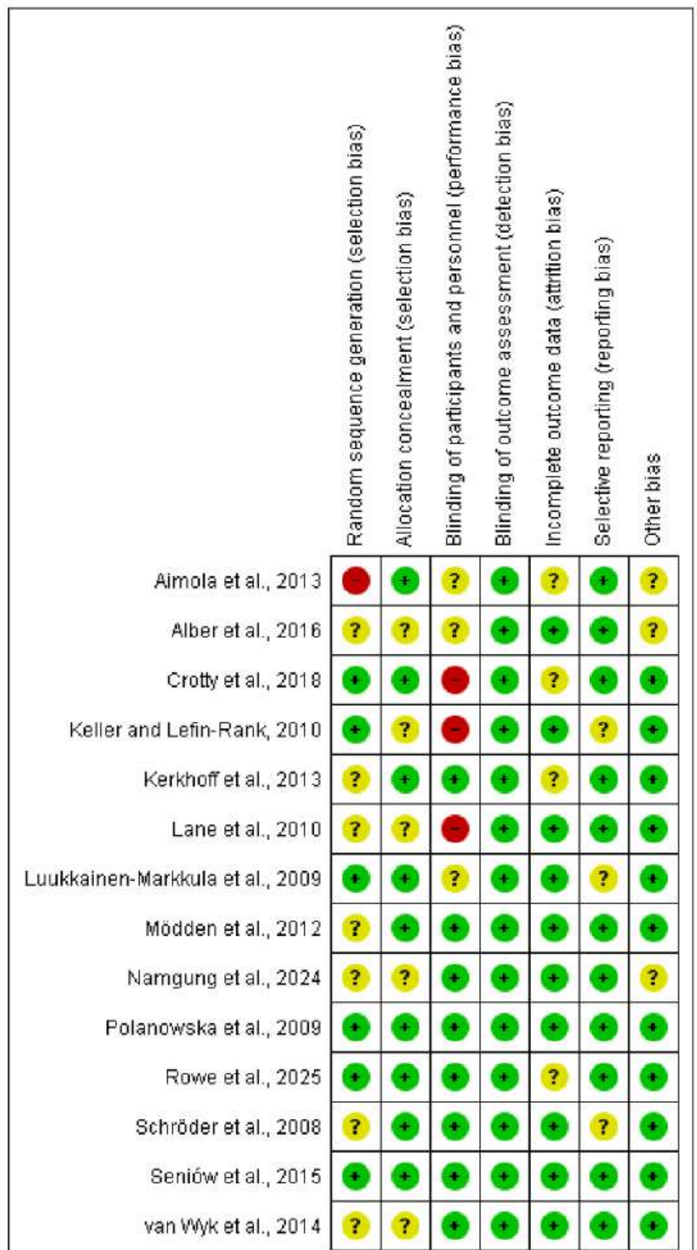

Figure 3. Risk of bias summary (Cochrane RoB 2 tool for RCTs)

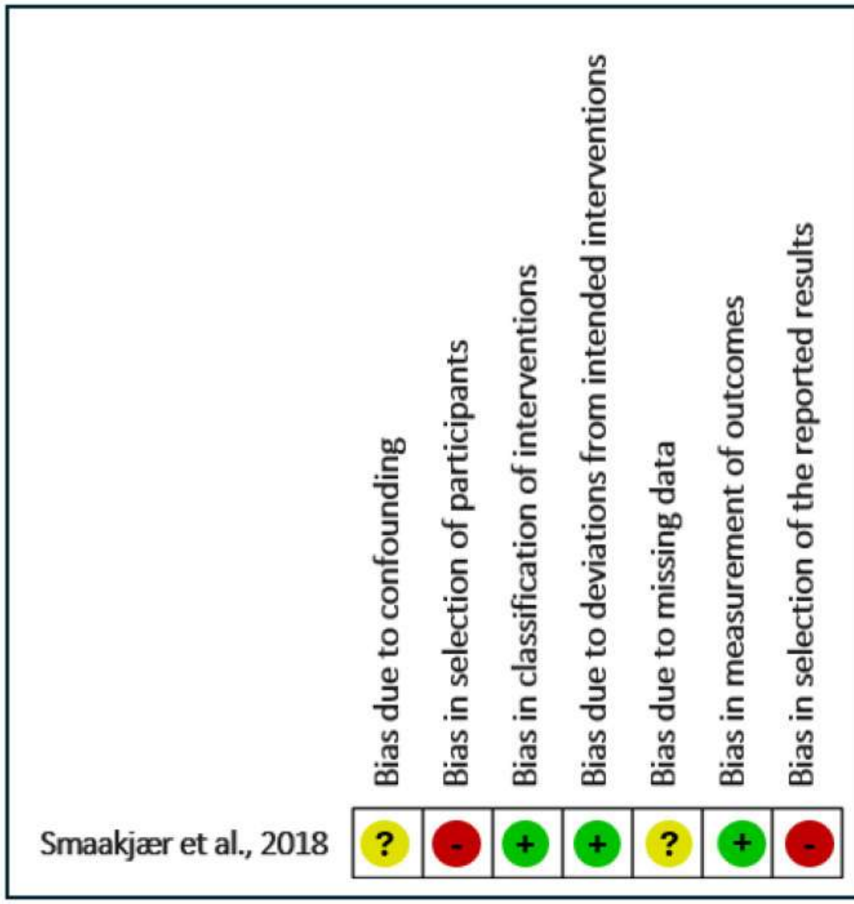

Figure 4. Risk of bias summary (ROBINS-I tool for non-randomized studies)

visual pathways and promote cortical reorganization through experience-dependent plasticity.[29,38] However, the overall evidence remains mixed. Although some studies have reported improvements in trained tasks or selected visual measures, robust evidence demonstrating substantial and consistent expansion of absolute visual field boundaries remains limited. This uncertainty is further complicated by the long-standing criticism that apparent perimetric improvements may partly reflect adaptive eye movements, including microsaccades, rather than genuine restitution of primary visual cortical processing.[20,24] Moreover, the clinical relevance of such changes remains debated, as small visual field expansions do not necessarily translate into meaningful improvements in daily activities. Therefore, restorative approaches should be considered promising but still investigational, rather than established strategies for routine clinical implementation.

A separate and more consistent signal in this review concerns interventions that engage multisensory or broader network-level mechanisms, particularly in patients with visuospatial neglect. In neglect rehabilitation, studies combining visual training with somatosensory stimulation, arm activation, smooth pursuit, or integrated task-specific physiotherapy generally produced more convincing gains than purely visual or purely top-down strategies alone.[39,40] This pattern is neurobiologically plausible because visuospatial neglect is not simply a sensory field loss, but a disorder of distributed attention networks, multisensory integration, and spatial representation. Likewise, audiovisual exploration paradigms in hemianopia support the possibility that alternative pathways, including the retino-colliculo-extrastriate route, may be harnessed to improve orienting and functional exploration even when the primary visual cortex has been injured.[21,31] Together, these studies suggest that rehabilitation strategies aligned with large-scale network physiology may have greater translational value than narrowly defined single-modality training.

Finally, the findings of this review align with current international guidance that emphasizes early identification, specialist orthoptic involvement, and individualized treatment planning rather than a universal rehabilitation template. Contemporary recommendations from NICE and the European Stroke Organization support systematic early screening for post-stroke visual impairment and acknowledge that different syndromes, such as hemianopia, ocular motility disorders, and visuospatial neglect, require distinct diagnostic and therapeutic pathways.[27,33,37] In practice, however, some interventions may operate through overlapping mechanisms, and their clinical value is better judged by the consistency and relevance of the outcomes achieved than by their theoretical label alone. At present, compensatory approaches have more consistent support for functional benefit, whereas restorative and neuromodulatory approaches remain under active investigation.[33,37]

At present, the compensatory model has stronger functional evidence base. Visual scanning training remains the most established approach for homonymous field defects because it directly addresses a clinically meaningful problem, namely failure to explore contralesional space efficiently. Improvements reported in earlier studies were generally seen in visual search tasks, reading behavior, environmental awareness, and patient-reported performance in daily activities.[17,19,24] This pragmatic orientation likely explains why compensatory therapy has remained attractive to clinicians: even if the blind field is not biologically restored, patients may still become safer, faster, and more independent. Importantly, this functional focus is consistent with stroke rehabilitation principles more broadly, where meaningful participation and task performance often matter more than isolated impairment metrics.[19]

Where the literature becomes more encouraging is in hybrid or network-oriented approaches that combine compensatory practice with broader neurobiological facilitation. In hemianopia, audiovisual exploration training appears to outperform purely visual exploration in some studies, which is consistent with activation of multisensory orienting systems involving the superior colliculus and pulvinar rather than exclusive reliance on the damaged geniculostriate pathway.[19,20] In neglect, smooth pursuit, contralesional limb activation, and visual training combined with somatosensory stimulation appear more effective than purely top-down instruction in several studies, likely because they engage distributed attentional and sensorimotor networks rather than depending solely on conscious effort.[21,31,39] These findings suggest that the most effective rehabilitation may not fit neatly into a pure compensatory or pure restorative category. Still, they may instead work by coupling behavioral adaptation with modulation of spared multisensory circuits.

Non-invasive brain stimulation further reinforces this middle ground between compensation and restoration. Recent systematic review evidence suggests that neuromodulation may improve visual perception after stroke. However, the evidence remains limited by small samples, heterogeneity of stimulation protocols, and insufficient long-term follow-up. From a clinical standpoint, the comparison between compensatory and restorative approaches suggests that clinicians should prioritize systematic early screening for all stroke survivors to ensure prompt detection of visual and neglect deficits. Compensatory rehabilitation currently has better support for functional benefit and remains the most defensible option for routine practice, especially for improving navigation, reading, and daily performance. Restorative rehabilitation remains promising, particularly when combined with neuromodulation or immersive high-dose training, but still lacks sufficiently consistent evidence for unequivocal visual field restitution. For this reason, current guideline-oriented practice should prioritize early specialist referral, accurate phenotyping, and individualized treatment selection developed through interdisciplinary collaboration between physicians, orthoptists, and therapists. Patients with stable chronic deficits may benefit most from function-oriented compensatory and multisensory strategies. In contrast, restorative or neuromodulatory protocols may be best considered as targeted adjuncts, ideally within closely monitored programs or research settings. This balanced interpretation is more consistent with the current evidence than endorsing either paradigm in absolute terms.[27,33,34]

The findings of this review offer practical guidance for neurological physiotherapists, emphasizing that rehabilitation strategies should be tailored to the specific visual disorder subtype. For homonymous hemianopia, compensatory visual scanning training (VST) remains the first-line approach. Physiotherapists should integrate saccadic eye movements into functional tasks such as obstacle navigation, transfers, and reading, with an emphasis on real-world practice. For visuospatial neglect, multisensory and network-oriented strategies, such as smooth pursuit eye movements, contralesional limb activation, and somatosensory stimulation are more effective than visual training alone. Simple verbal prompts are insufficient; instead, physiotherapists can use tactile or auditory cues to facilitate automatic orienting to the neglected side. For oculomotor dysfunction (e.g., diplopia, impaired pursuit), orthoptic referral is essential, but physiotherapists can support rehabilitation through gaze stabilization and head-eye coordination exercises while adapting the environment (e.g., reducing clutter, using high-contrast targets). For visual perceptual deficits, evidence is sparser, but virtual reality-based and computerised perceptual training show promise, focusing on task-specific errors such as depth judgment or figure-ground discrimination. Across all subtypes, early systematic visual screening and individualised, goal-oriented rehabilitation are critical to improving mobility, independence, and quality of life.[21,31,39]

This review has several limitations. First, there was substantial heterogeneity across the included studies in terms of visual disorder subtypes, patient characteristics, intervention protocols, outcome measures, and follow-up duration, which limited comparability and precluded quantitative meta-analysis. Second, the number of studies for certain visual disorder subtypes was limited, and many included studies had relatively small sample sizes, reducing the overall strength and generalizability of the evidence. Third, methodological quality varied, with some studies presenting potential risks of bias related to randomization, allocation concealment, blinding, and attrition. Additionally, only English-language publications were included, which may have introduced language bias. Finally, most studies focused on short-term outcomes, with limited long-term follow-up, thereby restricting conclusions regarding the sustainability of rehabilitation effects.

CONCLUSION

Rehabilitation approaches for post-stroke visual disorders show potential benefits, particularly in improving functional outcomes such as visual exploration, reading performance, activities of daily living, and quality of life. However, the available evidence remains heterogeneous, and overly definitive conclusions regarding the superiority of specific interventions should be avoided. Individualized rehabilitation should be guided by the subtype of visual disorder, patient functional needs, and clinical goals within neurological physiotherapy practice. Further high-quality studies are needed to determine the most effective intervention protocols, using standardized outcome measures, larger sample sizes, adequate controls, and longer follow-up periods.

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Not applicable.

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Conflict of Interest

The authors declare that there are no conflicts of interest related to this work. No financial or personal relationships exist that could have influenced the objectivity of the study, the interpretation of the results, or the preparation of the manuscript.

Author Contribution

J.J. conceptualized and designed the review, supervised the overall process, and provided critical revisions. J.J., E.S, and P.A.A.. conducted the systematic literature search and data extraction. All authors contributed to the preparation of the manuscript and approved the final version for submission.

Generative AI Statement

The authors declare that generative artificial intelligence (AI) tools were utilized solely for language proofreading and grammatical refinement of the manuscript. The use of AI was strictly limited to improving clarity, coherence, and linguistic accuracy, without contributing to the scientific content, data analysis, interpretation, or conclusions of the study. All intellectual input, study design, data collection, analysis, and final approval of the manuscript remain the sole responsibility of the authors.

REFERENCES

1. Venketasubramanian N. Stroke Epidemiology in Asia. Cerebrovasc Dis Extra. 2025;15(1):81–92. Available from: 10.1159/000543399
2. Pula JH, Yuen CA. Eyes and stroke: The visual aspects of cerebrovascular disease. Stroke Vasc Neurol. 2017;2(4):210–20. Available from: 10.1136/svn-2017-000079
3. Rowe FJ, Hepworth LR, Howard C, Hanna KL, Currie J. Impact of visual impairment following stroke (IVIS study): a prospective clinical profile of central and peripheral visual deficits, eye movement abnormalities and visual perceptual deficits. Disabil Rehabil. 2022;44(13):3139–53. Available from: 10.1080/09638288.2020.1859631
4. Rowe FJ, Hepworth LR, Howard C, Hanna KL, Cheyne CP, Currie J. High incidence and prevalence of visual problems after acute stroke: An epidemiology study with implications for service delivery. PLoS One. 2019;14(3):e0213035. Available from: 10.1371/journal.pone.0213035
5. Rowe FJ, Hepworth LR, Begoña Coco-Martin M, Gillebert CR, Leal-Vega L, Palmowski-Wolfe A, et al. European Stroke Organisation (ESO) guideline on visual impairment in stroke. Eur Stroke J. 2025;10(4):1087–159. Available from: 10.1177/23969873251314693
6. Sand KM, Thomassen L, Næss H, Rødahl E, Hoff JM. Diagnosis and Rehabilitation of Visual Field Defects in Stroke Patients: A Retrospective Audit. Cerebrovasc Dis Extra. 2012;2(1):17–23. Available from: 10.1159/000337016
7. Smith TM, Pappadis MR, Krishnan S, Reistetter TA. Stroke survivor and caregiver perspectives on post-stroke visual concerns and long-term consequences. Behav Neurol. 2018;2018:1463429. Available from: 10.1155/2018/1463429
8. Rowe FJ, Wright D, Brand D, Maan T, Peel S, Akerman N, et al. Vision In Stroke cohort: Profile overview of visual impairment. Brain Behav. 2017;7(11):e00771. Available from: 10.1002/brb3.771
9. Hepworth LR, Howard C, Hanna KL, Currie J, Rowe FJ. "Eye" Don't See: An Analysis of Visual Symptom Reporting by Stroke Survivors from a Large Epidemiology Study. J Stroke Cerebrovasc Dis. 2021;30(6):105759. Available from: 0.1016/j.jstrokecerebrovasdis.2021.105759
10. Mathisen TS, Eilertsen G, Ormstad H, Falkenberg HK. 'If we don't assess the patient's vision, we risk starting at the wrong end': a qualitative evaluation of a stroke service knowledge translation project. BMC Health Serv Res. 2022;22(1):351. Available from: 10.1186/s12913-022-07732-w
11. Mathisen TS, Eilertsen G, Ormstad H, Falkenberg HK. Barriers and facilitators to the implementation of a structured visual assessment after stroke in municipal health care services. BMC Health Serv Res. 2021;21(1):497. Available from: 10.1186/s12913-021-06467-4
12. Rowe FJ, Hepworth L, Howard C, Bruce A, Smerdon V, Payne T, et al. Vision Screening Assessment (VISA) tool: Diagnostic accuracy validation of a novel screening tool in detecting visual impairment among stroke survivors. BMJ Open. 2020;10(6):e033639. Available from: 10.1136/bmjopen-2019-033639
13. Rowe FJ. Accuracy of referrals for visual assessment in a stroke population. Eye. 2011;25(2):161–7. Available from: 10.1038/eye.2010.173
14. Pollock A, Hazelton C, Rowe FJ, Jonuscheit S, Kernohan A, Angilley J, et al. Interventions for visual field defects in people with stroke. Cochrane Database Syst Rev. 2019;2019(5):CD008388. Available from: 10.1002/14651858.CD008388.pub3
15. Hazelton C, McGill K, Campbell P, Todhunter-Brown A, Thomson K, Nicolson DJ, et al. Perceptual Disorders After Stroke: A Scoping Review of Interventions. Stroke. 2022;53(5):1772–87. Available from: 10.1161/STROKEAHA.121.035671
16. Hanna KL, Hepworth LR, Rowe FJ. The treatment methods for post-stroke visual impairment: A systematic review. Brain Behav. 2017;7(5):e00682. Available from: 10.1002/brb3.682
17. Aimola L, Lane AR, Smith DT, Kerkhoff G, Ford GA, Schenk T. Efficacy and feasibility of home-based training for individuals with homonymous visual field defects. Neurorehabil Neural Repair. 2014;28(3):207–18. Available from: 10.1177/1545968313503219
18. Alber R, Moser H, Gall C, Sabel BA. Combined Transcranial Direct Current Stimulation and Vision Restoration Training in Subacute Stroke Rehabilitation: A Pilot Study. PM R. 2017;9(8):787–94. Available from: 10.1016/j.pmrj.2016.12.003
19. Crotty M, Van Den Berg M, Hayes A, Chen C, Lange K, George S. Hemianopia after stroke: A randomized controlled trial of the effectiveness of a standardised versus an individualized rehabilitation program, on scanning ability whilst walking. NeuroRehabilitation. 2018;43(2):201–9. Available from: 10.3233/NRE-172377
20. Keller I, Lefin-Rank G. Improvement of visual search after audiovisual exploration training in hemianopic patients. Neurorehabil Neural Repair. 2010;24(7):666–73. Available from: 10.1177/1545968310372774
21. Kerkhoff G, Reinhart S, Ziegler W, Artinger F, Marquardt C, Keller I. Smooth pursuit eye movement training promotes recovery from auditory and visual neglect: A randomized controlled study. Neurorehabil Neural Repair. 2013;27(9):789–98. Available from: 10.1177/1545968313491012
22. Lane AR, Smith DT, Ellison A, Schenk T. Visual exploration training is no better than attention training for treating hemianopia. Brain. 2010;133(6):1717–28. Available from: 10.1093/brain/awq088
23. Luukkainen-Markkula R, Tarkka IM, Pitkänen K, Sivenius J, Hämäläinen H. Rehabilitation of hemispatial neglect: A randomized study using either arm activation or visual scanning training. Restor Neurol Neurosci. 2009;27(6):663–72. Available from: 10.3233/RNN-2009-0520
24. Mödden C, Behrens M, Damke I, Eilers N, Kastrup A, Hildebrandt H. A randomized controlled trial comparing 2 interventions for visual field loss with standard occupational therapy during inpatient stroke rehabilitation. Neurorehabil Neural Repair. 2012;26(5):463–9. Available from: 10.1177/1545968311425927
25. Namgung E, Kwon SU, Han MK, Kim GM, Kim HY, Park KY, et al. Digital therapeutics using virtual reality-based visual perceptual learning for visual field defects in stroke: A double-blind randomized trial. Brain Behav. 2024;14(5):1–12. Available from: 10.1002/brb3.3525
26. Polanowska K, Seniów J, Paprot E, Lesniak M, Czlonkowska A. Neuropsychological Rehabilitation : An International Left-hand somatosensory stimulation combined with visual scanning training in rehabilitation for post-stroke hemineglect : A randomised , double-blind study. Neuropsychol Rehabil An Int J. 2009;19(3):364–82. Available from: 10.1080/09602010802268856
27. Rowe FJ, Brayshaw E, Brown M, Chatterjee K, Drummond A, Hazelton C, et al. A randomized controlled trial of Scanning Eye trAining as a Rehabilitation Choice for Hemianopia after stroke (SEARCH). Int J Stroke. 2025;20(8):968–76. Available from: 10.1177/17474930251330140
28. Schröder A, Wist ER, Hömberg V. TENS and optokinetic stimulation in neglect therapy after cerebrovascular accident: A randomized controlled study. Eur J Neurol. 2008;15(9):922–7. Available from: 10.1111/j.1468-1331.2008.02229.x

29. Seniów J, Polanowska K, Leśniak M, Członkowska A. Adding transcutaneous electrical nerve stimulation to visual scanning training does not enhance treatment effect on hemispatial neglect: a randomized, controlled, double-blind study. Top Stroke Rehabil. 2016;23(6):377–83. Available from: 10.1179/1074935715Z.00000000058
30. Smaakjær P, Tødten ST, Rasmussen RS. Therapist-assisted vision therapy improves outcome for stroke patients with homonymous hemianopia alone or combined with oculomotor dysfunction. Neurol Res. 2018;40(9):752–7. Available from: 10.1080/01616412.2018.1475321
31. Van Wyk A, Eksteen CA, Rheeder P. The effect of visual scanning exercises integrated into physiotherapy in patients with unilateral spatial neglect poststroke: A matched-pair randomized control trial. Neurorehabil Neural Repair. 2014;28(9):856–73. Available from: 10.1177/1545968314526306
32. Esposito E, Shekhtman G, Chen P. Prevalence of spatial neglect post-stroke: A systematic review. Ann Phys Rehabil Med. 2021;64(5):101459. Available from: 10.1016/j.rehab.2020.10.010
33. Rowe FJ, Hepworth LR, Howard C, Hanna KL, Cheyne CP, Currie J. High incidence and prevalence of visual problems after acute stroke: An epidemiology study with implications for service delivery. PLoS One. 2019;14(3):1–16. Available from: 10.1371/journal.pone.0213035
34. Overman MJ, Binns E, Milosevich ET, Demeyere N. Recovery of Visuospatial Neglect with Standard Treatment: A Systematic Review and Meta-Analysis. Stroke. 2024;55(9):2325–39. Available from: 10.1161/STROKEAHA.124.046760
35. Saionz EL, Cavanaugh MR, Johnson BA, Harrington D, Aguirre GK, Huxlin KR. Evolution of Visual Field Defects After Occipital Stroke: A Quantitative Analysis. Transl Vis Sci Technol. 2025;14(6):14. Available from: 10.1167/tvst.14.6.14
36. Zihl J, Kentridge RW, Pargent F, Heywood CA. Aging and the rehabilitation of homonymous hemianopia: The efficacy of compensatory eye-movement training techniques and a five-year follow up. Aging Brain. 2021;1:100012. Available from: 10.1016/j.nbas.2021.100012
37. Rowe FJ, Hepworth LR, Begoña Coco-Martin M, Gillebert CR, Leal-Vega L, Palmowski-Wolfe A, et al. European Stroke Organisation (ESO) guideline on visual impairment in stroke. Eur Stroke J. 2025;10(4):1087–159. Available from: 10.1177/23969873251314693
38. Schow T, Harris P, Teasdale TW, Rasmussen MA. Evaluation of a four month rehabilitation program for stroke patients with balance problems and binocular visual dysfunction. NeuroRehabilitation. 2016;38(4):331–41. Available from: 10.3233/NRE-161324
39. Polanowska K, Seniow J, Paprot E, Leniak M, Czonkowska A. Left-hand somatosensory stimulation combined with visual scanning training in rehabilitation for post-stroke hemineglect: A randomised, double-blind study. Neuropsychol Rehabil. 2009;19(3):364–82. Available from: 10.1080/09602010802268856
40. Luukkainen-Markkula R, Tarkka IM, Pitkänen K, Sivenius J, Hämäläinen H. Rehabilitation of hemispatial neglect: A randomized study using either arm activation or visual scanning training. Restor Neurol Neurosci. 2009;27(6):663–72. Available from: 10.3233/RNN-2009-0520