Occupational Therapy Interventions to Improve Reading Performance of Older Adults With Low Vision: A Systematic Review

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Importance: Low vision affects many older adults and is expected to significantly increase over the next several decades. It has a significant impact on all aspects of daily life, including the reading required for participation in occupations.

Objective: To determine the effectiveness of interventions within the scope of occupational therapy to improve reading required for the performance of occupations by older adults with low vision.

Data Sources: We conducted a systematic review of literature published in the Cochrane Database of Systematic Reviews, MEDLINE, PsycINFO, CINAHL, and OTseeker databases from 2010 through 2016. The references of retrieved articles were also hand searched.

Study Selection and Data Collection: Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines were used to abstract and assess data quality and validity. This review followed the established methodology of the American Occupational Therapy Association Evidence-Based Practice Project.

Findings: Sixteen articles met the inclusion criteria and were categorized into three themes: (1) technology, (2) visual skills training, and (3) multicomponent interventions. Moderate evidence supports stand-based electronic magnification and eccentric viewing training to improve reading outcomes. Strong evidence supports multicomponent interventions.

Conclusions and Relevance: Occupational therapy practitioners working with older adults with low vision are strongly encouraged to integrate stand-based electronic magnification, eccentric viewing training, and comprehensive low vision services into routine care. Further research with larger sample sizes and functional reading outcome measures is needed.

What This Article Adds: This review provides additional support for the use of select occupational therapy interventions (stand-based electronic magnification, eccentric viewing training, and comprehensive low vision services) to support the reading required for occupational performance for older adults with low vision. The findings provide guidance to occupational therapy practitioners for selection and implementation of evidence-based interventions for reading.

Low vision affects approximately 15% of Americans older than age 65 ([Federal Interagency Forum on Aging-Related Statistics, 2012](#)), and this percentage is expected to double by 2050 ([National Institutes of Health, 2016](#)). Low vision has a significant impact on all aspects of daily life, including reading required for participation in occupations. The aim of this systematic review was to determine the effectiveness of interventions within the scope of occupational therapy to improve reading required for the performance of occupations by older adults with low vision.

Background

Low vision is a permanent loss of visual acuity or visual field that cannot be corrected through surgical, pharmaceutical, or optical intervention ([U.S. Department of Health and Human Services, 2004](#)). Although this loss of visual function can affect all aspects of daily life, the most frequently reported reason for seeking services is difficulty with reading tasks ([Owsley et al., 2009](#)). Occupational therapy can help clients learn to adapt to their vision loss and to use effective

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compensatory strategies to participate in meaningful occupations. Interventions include technology, visual skills training, and multicomponent interventions.

Technology used in interventions for older adults with visual impairment includes hand and stand magnifiers, telescopes, and electronic magnification devices. These devices are commonly prescribed to assist clients in maintaining participation in reading tasks required for activities of daily living, instrumental activities of daily living, and leisure tasks. With advances in technology, use of mainstream devices, such as tablets and e-readers, to enhance reading performance has become increasingly common (Gill et al., 2013; Kaldenberg & Smallfield, 2017; Mednick et al., 2017).

For some clients with central or peripheral field impairments, systematic training in the use of residual vision can be effective in improving reading performance. This article discusses vision skills training related to central visual field impairment and hemianopsia. For clients with central visual field impairment, eccentric viewing training includes rapid serial presentation training and controlled eye movement training. For clients with hemianopsia, visual skills training includes compensatory systematic scanning training, computer-based visual search training, and audiovisual stimulation training.

Often, low vision rehabilitation services include multicomponent interventions that provide multiple strategies to improve participation in meaningful occupations, including reading. These interventions may include group therapy, education about the client's eye condition and available resources, training in problem-solving strategies, environmental modification (e.g., lighting), training in the use of low vision devices, instruction in adaptive strategies and work simplification, training in techniques for reading, education regarding adjustment to vision loss, and training in performance of daily occupations.

A previous systematic review of the literature regarding the effectiveness of interventions to enhance reading required for the performance of occupations found 32 articles that supported interventions within the scope of occupational therapy for the outcome of reading performance (Smallfield et al., 2013). The authors found strong evidence supporting low vision programs that included occupational therapy and moderate evidence supporting electronic magnification. Moderate evidence supported the use of lighting to improve reading performance. Limited evidence was found to support eccentric viewing training and optical magnification. The effectiveness of optical magnifiers, text eccentric viewing, characteristic preferences, and line guides within optical magnification was unclear (Smallfield et al., 2013). Building on this evidence, the purpose of the current systematic review was to identify and analyze new evidence for the effectiveness of interventions within the scope of occupational therapy practice to promote reading required for the performance of occupations by older adults with low vision.

Method

This systematic review is one of three reviews of the literature on older adults with low vision supported by the American Occupational Therapy Association (AOTA) as part of the Evidence-Based Practice (EBP) Project (see also Liu & Chang, 2020, and Nastasi, 2020, in this issue). The method for the review was specified in advance and documented in a protocol for the review authors.

Search Strategy

Search terms for the review were identified by the methodology consultant to the EBP Project and AOTA staff in consultation with the review authors and an advisory group. The search terms were identified to capture pertinent studies and to ensure that the terms relevant to the specific thesaurus of each database were included. Table 1 lists the search terms used in this review specifically related to the population (older adults with low vision) and types of interventions. A medical research librarian with experience in completing systematic review searches conducted the search in the Cochrane Database of Systematic Reviews, MEDLINE, PsycINFO, CINAHL, and OTseeker databases.

Table 1. Search Terms for Reading Performance for Older Adults With Low Vision

Category	Key Search Terms
Population age and diagnoses	aging, elderly, older adults, seniors age-related macular degeneration, blindness, cataracts, central visual impairment, Charles Bonnet syndrome, diabetic retinopathy, dual sensory impairment, glaucoma, hemianopia, hemianopsia, light sensitivity, low vision, macula, macular edema, macular hole, oculomotor control, partial vision, partially sighted, peripheral visual impairment, photophobia, retina, retinitis pigmentosa, scotoma, Stargardt's disease, visual acuity, visual disorder, visual field, visual hallucination, visual impairment, visually impaired persons
Intervention	accessibility, activities of daily living, adaptive equipment, adult education, aging in place, ambient lighting, anxiety, assistive technology, audio device, bathing, behavioral activation, bifocals, bioptics, client education, closed circuit television (CCTV), cognitive behavior therapy, community mobility, compensation, compensatory techniques, computer tablet, contrast sensitivity, cooking, coping, cultural activities, dark–light adaptation, depression, device training, dressing, driving, driving restrictions, driving retirement, Dynavision, eating, eccentric viewing, education, electronic magnification, electronic reading device, electronic reading software, emergency preparedness, employment, environment, environmental modification, ergonomics, exercise, fall prevention, falls, family, fear of falling, field enhancement, field expansion, filtered lenses, foot care, friends, friendship, gardening, glare, glare control, handwriting, health literacy, health management, hobbies, illumination, instrumental activities of daily living, intervention, iPad, job, labeling, large print, laundry, leisure, leisure activity, lighting, loneliness, low vision devices, low vision rehabilitation, low vision training, magnification, meal preparation, medication management, meditation, mental health, microscopic glasses, MNRead acuity chart, mobile phone use, mobility, money management, nap, non-optical device, occupational therapy, optical device, optical magnification, optics, participation, Pepper Visual Skills for Reading Test, person environment fit, physical activity, preferred retinal locus training, prisms, problem solving, processing speed, psychosocial adaptation, reaction time, reading, reading comprehension, reading device, reading fluency, reading rate, reading speed, recreation, rehabilitation, relative distance, relative size, relaxation, rest, restrictive licensing, retirement, safety, scotoma awareness, self-management, sensory aids, shopping, sleep, sleep hygiene, social isolation, socialization, social participation, social support, spectral filters, spirituality, sports, stress, support system, tablet technology, tactile cues, tactile marking, task lighting, telephone, telescopes, television, toileting, traffic safety, transportation, travel, trip hazards, useful field of view, video magnification, vision training, visual cues, visual field, visual skills training, volunteer, watching television, wayfinding, web design, work, writing
Study and trial designs	appraisal, best practices, case control, case report, case series, clinical guidelines, clinical trial, cohort, comparative study, consensus development conferences, controlled clinical trial, critique, cross over, cross-sectional, double blind, epidemiology, evaluation study, evidence-based, evidence synthesis, feasibility study, follow-up, health technology assessment, intervention, longitudinal, main outcome measure, meta-analysis, multicenter study, observational study, outcome and process assessment, pilot, practice guidelines, prospective, random allocation, randomized controlled trial, retrospective, sampling, scientific integrity review, single subject design, standard of care, systematic literature review, systematic review, treatment outcome, validation study

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The methodology consultant for the EBP Project did the initial review of the search results, eliminating all records not relevant to the scope of the review. The review authors examined reference lists in the included articles for potential studies to ensure that all appropriate studies were included.

Eligibility Criteria

Several inclusion and exclusion criteria outlined the structure for the quality, type, and years of publication of the literature incorporated into the review. This review included peer-reviewed scientific literature published in English between 2010 and 2016. The intervention approaches examined were within the scope of practice of occupational therapy. Participants were older adults living with low vision with an average age of ≥ 55 yr. The review excluded data from presentations, conference proceedings, non-peer-reviewed research literature, dissertations, and theses. Studies with no outcomes related to reading were excluded.

AOTA uses standards of evidence modeled on those developed in evidence-based medicine (Sackett, 1989):

- Level I: Meta-analyses, systematic reviews, randomized controlled trials (RCTs)
- Level II: Two-group, nonrandomized studies (e.g., cohort, case-control)
- Level III: One-group, nonrandomized studies (e.g., before and after, pretest and posttest)
- Level IV: Descriptive studies (single-subject design, case series)
- Level V: Case reports and expert opinions that include narrative literature reviews and consensus statements.

Data Extraction

The authors conducted an initial review of the literature individually and then worked collaboratively to reach a consensus on all studies. Key information from each study included in the review was extracted in an evidence table ([Table 2](#), at the end of this article), and the study topics were synthesized into themes. The EBP Project methodology consultant reviewed the evidence table to ensure quality control.

Analysis

Each theme was analyzed for strength of evidence to assist in determining final recommendations for occupational therapy education, practice, and research. Analysis of study design, findings, and risk of bias determined the strength of evidence designation. The strength of evidence provided by the studies as a whole was determined in accordance with AOTA guidelines based on the [U.S. Preventive Services Task Force \(2014\)](#) recommendations:

- *Strong evidence* indicates consistent results from well-conducted studies, usually at least two RCTs.
- *Moderate evidence* indicates one well-conducted RCT or multiple moderate quality studies (Level II or III). The available evidence is sufficient to determine health outcomes, but confidence in the evidence is constrained by factors such as the number, size, or quality of individual studies or by inconsistency of findings across individual studies.
- *Low evidence* indicates a small number of low-level studies, flaws in the available studies, and some inconsistency in findings across individual studies. The available evidence is insufficient to assess effects on health and other outcomes of relevance to occupational therapy with confidence.

Results

[Figure 1](#) is a flow diagram of article selection. The review team identified 16 articles describing 8 Level I RCTs, 2 Level II studies, and 6 Level III studies for inclusion in the final qualitative synthesis of interventions addressing reading.

Risk of Bias

Each article was assessed for risk of bias as described in the Cochrane risk-of-bias guidelines ([Higgins et al., 2011](#)). The authors collaborated to reach consensus on each category of bias assessed. Many of the studies included in this review had high risk of selection bias because of lack of randomization of participants to study groups. In addition, many studies had high risk for detection and performance bias because they were not blinded. [Table 3](#) (at the end of this article) summarizes the risk of bias for all articles included in this review.

Outcome Measures

Outcome measures used in the majority of studies included reading speed (words per minute) and reading duration. Additionally, self-report measures such as the [National Eye Institute \(2000\)](#) Visual Function Questionnaire (VFQ–25) were used in five studies. Few studies included in this review used functional outcome measures of reading.

Interventions to Enhance Reading

The 16 articles were categorized into three themes according to type of intervention: (1) technology, (2) visual skills training, and (3) multicomponent interventions. These findings are an update to the 2013 systematic review on the same focused question and theme ([Smallfield et al., 2013](#)) and provide either new or additional support to the existing body of evidence within each theme.

Figure 1. Flow diagram of article inclusion and exclusion process.

Note. Figure format from “Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement,” by D. Moher, A. Liberati, J. Tetzlaff, & D. G. Altman; The PRISMA Group, 2009, *PLoS Medicine*, 6(7), e1000097. <https://doi.org/10.1371/journal.pmed.1000097>

Technology.

The previous review (Smallfield et al., 2013) found limited strength of evidence to support the use of low vision devices (high-add spectacles, non-illuminated and illuminated handheld magnifiers, non-illuminated and illuminated stand magnifiers, high-plus lenses, telescopes, and electronic magnification) to improve reading performance because of the low methodological quality of the studies included. However, moderate evidence was found to support the use of stand-based electronic magnification (e.g., closed circuit television [CCTV]) to enhance reading required for the performance of occupations compared with other types of low vision devices.

The current review identified 4 additional studies (1 Level I, 1 Level II, 2 Level III) addressing the effectiveness of technology interventions addressing reading required for occupational performance. Two studies examined the effectiveness of vision-specific assistive tech-

nology. In an RCT examining the use of CCTVs, Burggraaff and colleagues (2012) found no significant differences on measures of reading performance between participants who received standardized training from a low vision therapist to use the CCTV and control participants who received only the standard delivery instructions. CCTV use by all participants increased their reading acuity and maximum reading speed and decreased the number of errors compared with reading with no CCTV. In a Level III pilot study with 12 participants, Moisseiev and Manis (2016) found that a portable artificial vision device (OrCam; Jerusalem, Israel) significantly increased reading performance of older adults with low vision compared with baseline and with other low vision devices the participants were already using.

Two studies examined use of mainstream technology for reading by older adults with low vision. In a Level II study, Gill et al. (2013) compared reading text on a computer tablet and an e-reader to reading text on paper. Older adults with low vision who used an iPad with larger text sizes read significantly faster than when reading text on paper. The participants also read significantly faster with paper than with the e-reader. Kaldenberg and Smallfield (2017; Level III)

studied the feasibility of a computer tablet group training program to improve occupational performance of four participants. Performance and Satisfaction ratings on the Canadian Occupational Performance Measure (Law et al., 2005) showed mean increases of 3.45 and 3.65, respectively; improvement greater than 2 points is considered meaningful clinical change.

In summary, low evidence was found for the use of vision-specific assistive technology and mainstream technology to improve reading required for the performance of daily occupations. Moderate evidence continues to support stand-based electronic magnification and training.

Visual Skills Training.

Visual skills training typically refers to a structured or systematic form of visual exercise to improve awareness of the visual field (Kaldenberg & Smallfield, 2017). Definitions of vision skills training vary in the literature depending on the underlying visual deficit. In this review, we refer to vision skills training as it relates to central visual field impairment and hemianopsia. For clients with central visual field impairment, visual skills training includes eccentric viewing training, both rapid serial presentation training and controlled eye movement training (Chung, 2011; Palmer et al., 2010; Seiple et al., 2011). For clients with hemianopsia, visual skills training includes compensatory systematic scanning training, computer-based visual search training, and audiovisual stimulation training (Aimola et al., 2014; de Haan et al., 2015; Hayes et al., 2012; Jacquin-Courtois et al., 2013; Keller & Lefin-Rank, 2010; Mödden et al., 2012; Schuett et al., 2012).

The previous review (Smallfield et al., 2013) found limited evidence from 2 Level I studies, 1 Level II study, and 1 Level III study with limited sample sizes supporting eccentric viewing training for central visual field impairment (Frennesson et al., 1995; Kabanarou & Rubin, 2006; Vukicevic & Fitzmaurice, 2005, 2009). We found 10 additional studies in the theme of visual skills training. Three studies addressed the effectiveness of visual skills training for central visual field impairment. Moderate evidence from 1 Level I RCT (Seiple et al., 2011) and 2 Level III studies (Chung, 2011; Palmer et al., 2010) supports the use of eccentric viewing training, with controlled eye (steady eye) movements, to improve reading speed and duration. One of the Level III studies (Palmer et al., 2010) also found significant improvements in reading comprehension, and the other found no improvements in visual acuity, critical print size measurements, location of the functional preferred retinal locus, or fixation stability (Chung, 2011).

The previous systematic review did not address visual skills training for people with hemianopsia (Smallfield et al., 2013); we include 7 articles addressing this intervention in this review. Four Level I studies (Aimola et al., 2014; de Haan et al., 2015; Keller & Lefin-Rank, 2010; Mödden et al., 2012), 1 Level II study (Jacquin-Courtois et al., 2013), and 2 Level III studies (Hayes et al., 2012; Schuett et al., 2012) provide low evidence for the effectiveness of visual skills training for older adults with hemianopsia to improve reading required for occupational performance. The results of these studies were inconsistent, and many had small samples, increasing the risk of bias. Two Level I studies showed no improvements in reading using compensatory scanning training or computer-based compensatory training (de Haan et al., 2015; Mödden et al., 2012). Two Level I studies found significant improvement in visual search and reading for participants who were provided 20 or more sessions of reading and visual exploration or audiovisual stimulation training (Aimola et al., 2014; Keller & Lefin-Rank, 2010).

In summary, moderate evidence supports the use of eccentric viewing training, specifically training in the steady eye technique, to improve reading speed and duration for older adults with central visual field impairment. Low evidence supports the use of visual skills training, such as compensatory systematic scanning training, computer-based visual search training, and audiovisual stimulation training, to improve reading performance for older adults with hemianopsia.

Multicomponent Interventions.

The previous systematic review (Smallfield et al., 2013) found strong evidence from 5 studies (4 Level I, 1 Level III) supporting low vision programs that included occupational therapy as part of interprofessional services for older adults

with low vision (Eklund & Dahlin-Ivanoff, 2007; Eklund et al., 2008; Markowitz et al., 2008; McCabe et al., 2000; Pankow et al., 2004). Occupational therapy interventions included group therapy, education about the eye condition and available resources, training in problem-solving strategies, environmental modification, training in the use of low vision devices, instruction in adaptive strategies and work simplification, training in techniques for reading, education regarding adjustment to vision loss, and training in performance of daily occupations.

The previous review (Smallfield et al., 2013) also included 5 studies of low vision rehabilitation programs that did not include occupational therapy but included a combination of interventions including a low vision examination, prognosis and education about the eye condition, low vision therapy, prescription of low vision devices, eccentric viewing training, and home visits (Goodrich et al., 2006; La Grow, 2004; Reeves et al., 2004; Scanlan & Cuddeford, 2004; Stelmack et al., 2008). Combined, these studies provide conflicting evidence regarding the interventions' effectiveness in improving reading required for the performance of occupations compared with either an alternative intervention or no intervention.

The current review found 2 Level I studies that add to the body of evidence for multicomponent interventions addressing reading required for the performance of occupations. Stelmack et al. (2012) completed a Level I RCT in which the intervention group received five weekly 2-hr vision therapy sessions, a home visit, 5 hr of homework each week, and low vision device prescription. Compared with a control group receiving no services, the intervention group improved significantly in reading and other visual function skills at 4-mo follow-up.

Rovner et al. (2013) conducted a Level I RCT in which the intervention group received problem-solving training along with goal setting and solution identification and a control group received supportive therapy with no focus on vision rehabilitation. The researchers found no significant differences between groups in reading performance measured with the VFQ-25. On the basis of this single study, it is unclear whether a problem-solving approach is an effective strategy to promote reading performance, and further investigation is warranted using a performance-based outcome measure.

In summary, there continues to be strong evidence to support multicomponent interventions that include vision therapy, low vision device prescription and training, environmental modification, and homework for older adults with low vision to support reading required for occupational performance.

Discussion and Implications

The purpose of this systematic review was to examine updated evidence for the effectiveness of interventions within the scope of occupational therapy to improve reading required for the performance of occupations by older adults with low vision. Results provide low evidence for the use of vision-specific assistive technology and mainstream technology, and therefore occupational therapy practitioners should use these interventions cautiously on a case-by-case basis as appropriate. Moderate evidence supports stand-based electronic magnification and training, which should be offered routinely.

Moderate evidence also supports the use of eccentric viewing training, specifically training in the steady eye technique, to improve reading speed and duration for older adults with central visual field impairment, and this intervention should be offered routinely. Low evidence supports the use of visual skills training, such as compensatory systematic scanning training, computer-based visual search training, and audiovisual stimulation training, to improve reading performance for older adults with hemianopsia, and therefore these interventions should be used cautiously on a case-by-case basis.

Strong evidence supports multicomponent interventions that include vision therapy, low vision device prescription and training, environmental modification, and homework, and such interventions should be provided routinely. Finally, low evidence exists on the use of a problem-solving approach for the outcome of reading performance, and therefore this intervention should be used cautiously on a case-by-case basis.

Implications for Occupational Therapy Education

Reading is an important skill necessary for the performance of many daily occupations. This review adds valuable evidence to support the role of occupational therapy in addressing the reading needs of older adults with low vision. As the population ages, the need for occupational therapy practitioners trained to address the occupational needs of older adults with low vision will increase. On the basis of the results of this review, occupational therapy curricula should include the following knowledge and skill training in low vision to facilitate reading performance:

- Knowledge of common low vision conditions and progression
- Functional implications of low vision for occupational performance
- Assessment of functional vision, including reading
- Stand-based electronic magnification and training
- Eccentric viewing training (steady eye training) for clients with central field impairment
- Visual search training for clients with neurological visual impairment
- Comprehensive multicomponent interventions that include low vision devices and training, home assessment and intervention, homework, psychosocial intervention, and eccentric viewing training
- Training in the use of standardized outcome measures for the outcome of reading to demonstrate intervention effectiveness
- Knowledge of the potential need for referral to an advanced practice clinician in the area of low vision for intervention beyond the generalist skill level.

Implications for Occupational Therapy Research

Occupational therapy has the potential to play a significant role in enhancing reading skills for older adults with low vision. This review contributes to the existing body of research in the area of occupational therapy interventions to improve reading required for occupational performance. However, the studies included in the review are limited by small sample sizes, research designs that do not include a control group, and lack of functional outcome measures. Future research on interventions to address reading for the performance of daily occupations should include

- The role and effectiveness of mainstream technology,
- Larger sample sizes and use of functional outcome measures,
- Ongoing study of the efficacy of problem-solving training for the outcome of reading,
- Analysis of single-component interventions within multicomponent low vision rehabilitation, and
- Occupational therapy practitioners in study design and as interventionists.

Implications for Occupational Therapy Practice

The results of this review indicate that occupational therapy practitioners working with older adults with low vision on reading performance should use the following interventions as part of routine service provision:

- Comprehensive low vision rehabilitation
- Eccentric viewing training (steady eye training).

Practitioners should use the following interventions on a case-by-case basis:

- Vision-specific assistive technology
- Mainstream technology to improve reading
- Visual search training for hemianopsia.

Limitations

Although the body of evidence to support interventions within the scope of occupational therapy to improve reading required for the performance of daily occupations is growing, the articles included in this review have several limitations. Seven of the 16 studies included small sample sizes, specifically fewer than 30 total participants. Additionally, many studies included outcome measures that were either self-report or not tied to functional activity. Seven articles included neurological visual diagnoses, which were not included in the previous review. Original research using qualitative methodology was not included in the review. New evidence supporting traditional low vision intervention strategies, such as hand and stand-based magnification, was not found in this updated systematic review. Only occupational therapists served as reviewers in this study, which may contribute to potential bias.

Conclusion

Low vision is a chronic condition common in older adults that leads to significant challenges in engagement in desired occupations that require reading. The aim of this updated systematic review was to determine the effectiveness of interventions within the scope of occupational therapy to improve reading required for performance of occupations for older adults with low vision. Moderate evidence supports the use of comprehensive low vision rehabilitation, stand-based electronic magnification, and eccentric viewing training (steady eye technique). Occupational therapy practitioners working with older adults with low vision are strongly encouraged to integrate these interventions into routine care for this population with the goal of improved reading for the performance of daily occupations. 📌

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Table 2. Evidence Table for Reading Performance for Older Adults With Low Vision

Author/Year	Level of Evidence/Study Design/Participants/ Inclusion Criteria	Intervention and Control	Outcome Measures	Results
Burggraaff et al. (2012)	Level I	Technology		
	Multicenter masked RCT	<i>Intervention</i> Delivery instructions from the CCTV supplier combined with outpatient standardized training from low vision therapists, 60-min sessions 1×/wk (<i>M</i> = 2 sessions)	• Dutch version of the RRC for reading acuity • Reading speed in wpm • Reading errors • Column-tracking time • Technical reading	No significant differences were found between groups. Reading acuity, speed, and accuracy improved in both groups with the CCTV.
	<i>N</i> = 122 randomized, <i>N</i> = 114 in intention-to-treat analysis (59.6% female)			
	Intervention group, <i>n</i> = 59 (<i>M</i> age = 75.4; 61.0% female) Control group, <i>n</i> = 55 (<i>M</i> age = 78.6; 58.2% female)	<i>Control</i> Delivery instructions only		
Gill et al. (2013)	<i>Inclusion Criteria</i> Age ≥18, prescribed a stand-mounted CCTV, fluent in Dutch, no indication of cognitive deficits			
	Level II	<i>Intervention</i> No intervention; reading speed assessed on an iPad, e-reader, and paper with varying text sizes	• Reading speed in wpm for paper, iPad, and e-reader • Mean change in wpm for changes in text size and device	Participants read significantly faster using an iPad with larger text sizes compared with paper.
	3-group, within-subjects	<i>Control</i> No control		Participants read significantly faster on paper compared with the e-reader.
	<i>N</i> = 27 (<i>M</i> age = 78.9; sex not reported)			
Kaldenberg & Smallfield (2017)	<i>Inclusion Criteria</i> Stable wet AMD in one or both eyes, would benefit from a low vision aid as indicated by ocular assessment by a retinal specialist			
	Level III	<i>Intervention</i> Group training in tablet use, 10 weekly sessions	• COPM • Daily tablet use	Daily tablet use increased from 15 min at pretest to 3.0 hr at posttest and 4.5 hr at follow-up.
	1-group pretest–posttest with follow-up	<i>Control</i> No control		COPM Performance scores showed a mean increase of 3.45 and COPM Satisfaction scores a mean increase of 3.65. Improvement of >2 points is considered meaningful clinical change.
	<i>N</i> = 4 (<i>M</i> age = 74.25; 100% female)			This study did not directly target the outcome of reading but used the COPM and an iPad to improve performance of and satisfaction with daily activities.

(Continued)

Table 2. Evidence Table for Reading Performance for Older Adults With Low Vision (Cont.)

Author/Year	Level of Evidence/Study Design/Participants/ Inclusion Criteria	Intervention and Control	Outcome Measures	Results
Moisseiev & Manis (2016)	Level III Prospective pilot study <i>N</i> = 12 (<i>M</i> age = 62; 50% female) <i>Inclusion Criteria</i> Age >18, legally blind with best-corrected visual acuity of 20/200 or worse in better-seeing eye	<i>Intervention</i> Training at enrollment on use of the portable artificial vision device (OrCam) by an experienced instructor, single 90- to 120-min session; after completing a 10-item test, participants were given the device to use in their regular settings for ≥ 1 hr/day over 1 wk <i>Control</i> No control	10-item functional test designed to include daily activities that are difficult for a person with low vision	Mean scores on the functional test improved significantly from baseline to after the first week of portable artificial vision device use. For 7 participants who also used their own low vision aids, the portable artificial vision device improved their mean test scores significantly compared with use of only their low vision aids and use of no low vision aids.
Visual Skills Training				
Aimola et al. (2014)	Level I Parallel-group RCT <i>N</i> = 70 (38.6% female), <i>N</i> = 52 at completion Intervention group, <i>n</i> = 28 (<i>M</i> age = 61.43) Control group, <i>n</i> = 24 (<i>M</i> age = 63.96) <i>Inclusion Criteria</i> Age ≥ 18 , HVEFs confirmed using monocular automatic perimetry, macular sparing	<i>Intervention</i> Reading and exploration training with difficulty adjusted on the basis of previous reading speed and accuracy, 35 hr total <i>Control</i> Visual attention tasks but no exploration or large horizontal eye movements, 35 hr total	<ul style="list-style-type: none"> • Perimetry using the Oculus Twinfield 2 perimeter and the Esterman preset program • Visual search using a find-the-number technique • Reading speed in wpm • Driving hazard perception • Obstacle avoidance • Visuomotor search • Test of Everyday Attention • Sustained Attention to Response Task • NEI VFQ-25 • Impact of Vision Impairment questionnaire 	The intervention group showed significantly greater improvements in visual searching and reading and greater subjective improvement compared with the control group.
Chung (2011)	Level III Pretest-posttest <i>N</i> = 6 (4 with AMD, 2 with Stargardt disease; <i>M</i> age = 73.8; 50% female) <i>Inclusion Criteria</i> Long-standing central vision loss	<i>Intervention</i> Training in RSVP reading, 6 weekly sessions with 300 sentences per session <i>Control</i> No control	<ul style="list-style-type: none"> • Monocular visual acuities using the Bailey Lovie high-contrast letter acuity chart • RSVP reading speeds in wpm for six print sizes • Location of the fPRL • Fixation stability 	<p>RSVP reading speeds improved 34%–70% (<i>M</i> = 53%). Reading speed improved significantly for all participants.</p> <p>No improvements were found in visual acuity, critical print size measurements, location of the fPRL, and fixation stability.</p>

(Continued)

Table 2. Evidence Table for Reading Performance for Older Adults With Low Vision (Cont.)

Author/Year	Level of Evidence/Study Design/Participants/ Inclusion Criteria	Intervention and Control	Outcome Measures	Results
de Haan et al. (2015)	Level I RCT with wait-list control <i>N</i> = 54 at randomization, <i>N</i> = 49 at analysis (<i>M</i> age = 56; 34.7% female) Intervention group, <i>n</i> = 26 (<i>M</i> age = 55; 30.8% female) Control group, <i>n</i> = 23 (<i>M</i> age = 57; 39.1% female) <i>Inclusion Criteria</i> HVFd; at least a quadrantanopia, restricted to one-half of the visual field, from acquired postchiasmic brain injury; time since onset >5 mo; binocular visual acuity of Snellen $\geq$ 0.5 (6/12 or 20/40, LogMAR 0.3); stable neurological and ophthalmological condition; stable eye and head motility; able to walk $\geq$ 50 m; MMSE score $\geq$ 24/30	<i>Intervention</i> InSight-Hemianopia Compensatory Scanning Training emphasizing systematic horizontal scanning rhythm, provided by occupational therapists, 15 60- to 90-min sessions over 10 wk totaling 18.5 hr <i>Control</i> Wait list; no intervention	<ul style="list-style-type: none"> • ETDRS 2000 Letter Chart for monocular visual acuity • Geoko Test for contrast sensitivity • RRC in wpm • Reading speed and correct answers with a 400-word paragraph • Scanning test with dot patterns • Hazard perception test • Tracking test • Percentage preferred walking speed • NEI VFQ-25 • Independent Mobility Questionnaire • Cerebral Visual Disorders questionnaire 	<p>No improvements were found in nonmobility visual skills, including reading, visual counting, and visual search.</p> <p>Participants reported greater success in avoiding obstacles by detecting peripheral stimuli while walking.</p>
	Level III 1-group pretest-posttest <i>N</i> = 13, <i>N</i> = 10 at completion (<i>M</i> age = 65.4; 50% female) <i>Inclusion Criteria</i> Acquired brain injury 2 wk to 6 mo before assessment, left or right homonymous hemianopia, MMSE score $\geq$ 25, corrected vision of $\geq$ 6/18, age $\geq$ 18, able to give informed consent	<i>Intervention</i> Standardized NVT visual scanning therapy program consisting of static scanning and mobility training provided by orientation and mobility instructors, occupational therapists, and low vision therapists, 1-hr sessions 3x/wk for 7 wk <i>Control</i> No control	<ul style="list-style-type: none"> • NEI VFQ-25 • LV VFQ-48 • Pepper Visual Skills Reading Test for speed and accuracy 	<p>Significant improvements were found in quality of life (NEI VFQ-25 and LV VFQ-48) at 3 mo postintervention.</p> <p>NVT training did not improve performance on reading tasks.</p> <p>Results of the Pepper test were not reported.</p>
	Level II Pretest-posttest with healthy control <i>N</i> = 13 Intervention group, <i>n</i> = 7 (<i>M</i> age = 58.9; 42.9% female) Control group, <i>n</i> = 6 (<i>M</i> age and sex not reported) <i>Inclusion Criteria</i> Unilateral visual field defect, chronic phase postinjury with normal or corrected-to-normal binocular visual acuity, macular sparing	<i>Intervention</i> Computer-based compensatory eye movement training using a ramp-step search paradigm, 8-min search tasks, 100 trials of each, in a single training session <i>Control</i> Same intervention for participants with no visual field defect	<ul style="list-style-type: none"> • Visual search task • Rapid scanning task • Reading task 	<p>The intervention group improved significantly on the visual search tasks but not on the rapid scanning or reading tasks.</p> <p>The control group showed no significant difference from pretest to posttest on any task.</p>
	Jacquin-Courtois et al. (2013)			

(Continued)

Table 2. Evidence Table for Reading Performance for Older Adults With Low Vision (Cont.)

Author/Year	Level of Evidence/Study Design/Participants/ Inclusion Criteria	Intervention and Control	Outcome Measures	Results
Keller & Lefin-Rank (2010)	Level I	<i>Intervention</i> AVT, 20 30-min sessions over 3 wk	• Visual exploration tests for reading and object search	The intervention group showed significant improvements compared with the control group on all outcomes.
	RCT	<i>Control</i> VT, 20 30-min sessions over 3 wk	• Impairment in ADLs questionnaire	
	<i>N</i> = 20 (40% female)		• Electro-oculography	
	Intervention group, <i>n</i> = 10 (<i>M</i> age = 54.7; 40% female)			
	Control group, <i>n</i> = 10 (<i>M</i> age = 63.6; 40% female)			
Mödden et al. (2012)	<i>Inclusion Criteria</i> Left- or right-sided visual field deficit			
	Level I	<i>Intervention</i> <i>RT group:</i> Computer-based stimulation of border areas of their visual field defects through perception of visual target within the visual field border, 15 30-min sessions over 3 wk	<i>Primary</i> <i>RT group</i> • Visual field expansion • Reading performance	Compared with the control group, the CT group showed better visual search performance, but the RT group did not experience a larger expansion of the visual field. No significant differences were found between groups in reading speed.
	<i>N</i> = 45 (42.2% female)	<i>CT group:</i> Training in visual search strategies through identification of critical targeted icon, 15 30-min sessions over 3 wk	<i>CT group</i> • Visual search performance • Reading performance	
	RT group, <i>n</i> = 15 (<i>M</i> age = 58.3; 33.3% female)			
	CT group, <i>n</i> = 15 (<i>M</i> age = 57.1; 40.0% female)		<i>Secondary</i> • Test Battery of Attentional Performance • Behavioral Inattention Test for visual exploration	
	Control group, <i>n</i> = 15 (<i>M</i> age = 59.0; 53.3% female)	<i>Control</i> Standard OT, including training focused on systematic eye movements toward lost visual field during ADLs, 15 30-min sessions over 3 wk	• Wechsler Memory Test for reading ability • German Extended Barthel Index	
Palmer et al. (2010)	<i>Inclusion Criteria</i> Inpatient rehabilitation patients with homonymous hemianopia and posterior cerebral artery stroke			
	Level III	<i>Intervention</i> Eccentric viewing training, on individual basis with a tutor, consisting of preferred eye identification, magnification and refraction correction using low vision aids, optimal lighting identification, and visual fixation strategies (steady eye), 1.5 hr 1×/wk for 3–4 sessions, followed by individualized homework tasks	• Reading speed • Font size using the Keeler N Series Near Vision Vocational Test Chart • Maximal duration of comfortable reading • Percentage of comprehension	Reading speed improved significantly from 48.0 to 71.9 wpm. 82.6% of participants improved, 6.5% did not improve, and 10.5% had decreased reading speed. Mean font size improved significantly from N14.3 to N11.5. Before the training, 3% of participants could read font size N10 or smaller; after the training, 36% could read N10 or smaller. Reading duration improved significantly from 1.7 min to 15.8 min. 95% of participants could read for a longer period after training. Percentage of comprehension improved significantly from 73.7% to 92.7%.
	Retrospective 1-group pretest–posttest			
	<i>N</i> = 300, <i>N</i> = 242 at completion (<i>M</i> age = 75.4; 68.2% female)			
	<i>Inclusion Criteria</i> Diagnosis of AMD	<i>Control</i> No control		

(Continued)

Table 2. Evidence Table for Reading Performance for Older Adults With Low Vision (Cont.)

Author/Year	Level of Evidence/Study Design/Participants/ Inclusion Criteria	Intervention and Control	Outcome Measures	Results
Schuett et al. (2012)	Level III Single-subject baseline and crossover design N = 36 (16.7% female) Group A, n = 18 (M age = 64.0; 16.7% female) Group B, n = 18 (M age = 63.7; 16.7% female) <i>Inclusion Criteria</i> Homonymous visual field loss, brain injury diagnosis by cranial computed tomography scan and/or magnetic resonance imaging scan, macular sparing	<i>Intervention</i> Group A: Computer-based VET (M = 12.3 sessions) followed by reading training (M = 11.6 sessions) Group B: Reading training (M = 12.6 sessions) followed by VET (M = 11.5 sessions) <i>Control</i> No control	<ul style="list-style-type: none"> • Reading speed in wpm • Visual exploration time • Number of errors 	Improvements in reading and visual exploration were significant for both groups, with no significant difference between groups. Specific training led to improvements in related functional tasks (e.g., reading training improved reading speed).
Seiple et al. (2011)	Level I RCT, repeated-measures, counterbalanced, crossover N = 36 Intervention group, n = 30 (median age = 79; 50% female) Control group, n = 6 (M age = 78.4, sex not reported) <i>Inclusion Criteria</i> Diagnosis of dry nonexudative AMD, visual acuity >20/400 in the better-seeing eye	<i>Intervention</i> Three vision rehabilitation training approaches: Module 1, visual awareness and eccentric viewing; Module 2, control of reading eye movements (steady eye); and Module 3, reading practice with sequential presentation of lexical information; 6 weekly 2-hr sessions for each approach <i>Control</i> No intervention; training delayed for 18 wk	<ul style="list-style-type: none"> • Sentence reading performance calculated by reading speed in wpm • LV VFQ-48 	Reading speed decreased by 8.4 ± 7.2 wpm after Module 1, increased by 27.3 ± 6.8 wpm after Module 2, and decreased by 9.8 ± 7.2 wpm after Module 3. Reading speeds improved significantly after Module 2 compared with Modules 1 and 3 (decrease in wpm). The control group experienced little change in reading speed but improved over the 18 wk by an average of 0.96 wpm.
Rovner et al. (2013)	Level I Single-masked RCT with attention control N = 241 (63.5% female) Intervention group, n = 121 (M age = 82.7; 67.8% female) Control group, n = 120 (M age = 82.8; 59.2% female) <i>Inclusion Criteria</i> Age ≥ 65 , bilateral AMD, visual acuity between 20/70 and 20/400 in the better-seeing eye, moderate difficulty performing a vision-functional activity (e.g., reading mail, attending social activities)	<i>Intervention</i> Problem-solving therapy consisting of determination of functional problems caused by vision loss and creation of goals and solutions to address the problems <i>Control</i> Nondirective supportive therapy consisting of empathy, respect, and optimism, with no focus on vision rehabilitation	<ul style="list-style-type: none"> • TVF • NEI VFQ-25 • Activities Inventory • Vision-related quality of life 	No significant differences were found between groups in TVF scores at 3 and 6 mo. No significant changes were found in NEI VFQ-25 scores. Vision-related quality of life improved more for the intervention group than the control group. The intervention group also exhibited more coping strategies.

(Continued)

Table 2. Evidence Table for Reading Performance for Older Adults With Low Vision (Cont.)

Author/Year	Level of Evidence/Study Design/Participants/ Inclusion Criteria	Intervention and Control	Outcome Measures	Results
Stelmack et al. (2012)	Level I RCT N = 100 (2% female) Intervention group, n = 44 (M age = 78.9; 0% female) Control group, n = 56 (M age = 79.9; 3.6% female)	Intervention Low vision intervention protocol consisting of 5 weekly 2-hr low vision therapy sessions, a home visit from a vision therapist, 5 hr/wk of homework, and low vision devices prescribed when appropriate and provided at no charge, over 2 mo Control Wait list; intervention was provided after trial concluded at 4 mo but before 1-yr follow-up	<ul style="list-style-type: none"> • LV VFQ-48 for reading ability, mobility, visual information processing, visual-motor skills, and overall visual ability 	<p>The intervention group improved significantly in all aspects of visual function (reading, mobility, visual information processing, and motor skills) compared with the control group from baseline to 4-mo follow-up.</p> <p>The control group improved significantly in all aspects of visual function except mobility from baseline to 1 yr.</p> <p>Overall, visual ability of the intervention group improved significantly more than that of the control group.</p>
<p><i>Note.</i> ADLs = activities of daily living; AMD = age-related macular degeneration; AVT = audiovisual stimulation training; CCTV = closed-circuit television; COPM = Canadian Occupational Performance Measure; CT = compensatory therapy; iPRL = preferred retinal locus for fixation; HVFDs = homonymous visual field defects; LV VFQ-48 = Veterans Affairs Low Vision Functioning Questionnaire; M = mean; MMSE = Mini-Mental State Examination; NEI VFQ-25 = National Eye Institute Vision Function Questionnaire-25 plus supplement; NVT = Neuro Vision Technology; OT = occupational therapy; RCT = randomized controlled trial; RRC = Radner Reading Charts; RSVP = Rapid Serial Visual Presentation; RT = restitution therapy; TVF = targeted vision function; VET = visual exploration training; VT = visual stimulation training; wpm = words per minute.</p> <p>This table is a product of AOTA's Evidence-Based Practice Project and the <i>American Journal of Occupational Therapy</i>. Copyright © 2020 by the American Occupational Therapy Association. It may be freely reproduced for personal use in clinical or educational settings as long as the source is cited. All other uses require written permission from the American Occupational Therapy Association. To apply, visit www.copyright.com.</p> <p><i>Suggested citation:</i> Smallfield, S., & Kaldenberg, J. (2020). Occupational therapy interventions to improve reading performance of older adults with low vision: A systematic review (Table 2). <i>American Journal of Occupational Therapy</i>, 74, 7401185030. https://doi.org/10.5014/ajot.2019.038380</p>				

Table 3. Risk-of-Bias Table

Citation	Selection Bias		Blinding of Participants and Personnel (Performance Bias)		Blinding of Outcome Assessment (Detection Bias)		Incomplete Outcome Data (Attrition Bias)	Selective Reporting (Reporting Bias)
	Random Sequence Generation	Allocation Concealment			Patient-Reported Outcomes	Objective Outcomes		
Aimola et al. (2014)	+	+	?	?	?	?	+	+
Burggraaff et al. (2012)	+	+	–	–	NA	+	+	+
Chung (2011)	–	–	–	–	NA	–	+	+
de Haan et al. (2015)	+	+	?	?	+	+	+	+
Gill et al. (2013)	–	–	–	–	–	–	+	+
Hayes et al. (2012)	–	–	–	–	–	–	–	–
Jacquin-Courtois et al. (2013)	–	–	–	–	NA	–	?	+
Kaldenberg & Smallfield (2017)	–	–	–	–	–	–	+	+
Keller & Lefin-Rank (2010)	+	–	?	?	+	?	?	+
Mödden et al. (2012)	+	–	+	+	NA	–	+	+
Moisseiev & Manis (2016)	–	–	–	–	–	–	+	+
Palmer et al. (2010)	–	–	–	–	NA	–	+	+
Rovner et al. (2013)	+	+	–	–	–	–	+	+
Schuetz et al. (2012)	?	?	?	?	NA	?	?	+
Seiple et al. (2011)	?	?	?	?	?	?	?	+
Stelmack et al. (2012)	?	?	–	–	+	+	+	+

Note. Categories for risk of bias are as follows: + = low risk of bias; ? = unclear risk of bias; – = high risk of bias. NA = not applicable because of study design. Risk-of-bias table format adapted from “Assessing Risk of Bias in Included Studies,” by J. P. T. Higgins, D. G. Altman, and J. A. C. Sterne, in *Cochrane Handbook for Systematic Reviews of Interventions* (Version 5.1.0), by J. P. T. Higgins and S. Green (Eds.), 2011, London: Cochrane Collaboration. Retrieved from <http://handbook-5-1.cochrane.org>. Copyright © 2011 by The Cochrane Collaboration.

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