Visual Information Processing Evaluation and Orthoptic and Vision Therapy (for Ohio Only)

Policy Number: CS131OH.C
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➲ Instructions for Use

Table of Contents **Page**

Related Policies

- Cognitive Rehabilitation and Coma Stimulation (for Ohio Only)
- Vision Services Not Routinely Covered (for Ohio Only)

Application

This Medical Policy only applies to the state of Ohio. Any requests for services that are stated as unproven or services for which there is a coverage or quantity limit will be evaluated for medical necessity using Ohio Administrative Code 5160-1-01.

Coverage Rationale

The following are proven and medically necessary:

- Orthoptic Therapy or Vision Therapy for treating Convergence Insufficiency

The following are unproven and not medically necessary due to insufficient evidence of efficacy:

- Orthoptic Therapy or Vision Therapy for treating **all** other indications not listed above
- Remote, online, and/or digital therapy for Amblyopia

Definitions

Amblyopia: Amblyopia is a decreased vision in one or both eyes due to abnormal vision development in infancy and childhood. In the first few years of life, the brain must learn to see or interpret the images provided by the eyes. In Amblyopia, the brain receives a poor image from one eye and thus does not learn to see well. Vision loss occurs in this case because nerve pathways between the brain and the eye are not properly stimulated. Amblyopia is often referred to as lazy eye [American Association for Pediatric Ophthalmology and Strabismus (AAPOS), 2019].

Convergence Insufficiency: Inability to maintain binocular function (keeping the two eyes working together) while working at a near distance. Typically, one eye will turn outward (intermittent Exotropia) when focusing on a word or object at near distance (AAPOS, 2020).

Esotropia: A form of Strabismus (eye misalignment) characterized by an inwards turn of one or both eyes. It may be intermittent or constant and may occur with near fixation, distance fixation, or both. The crossing may occur mostly with one eye or may alternate between eyes. It is the opposite of crossed eyes, or Exotropia. Esotropia may occur at any age (AAPOS, 2019).

Exotropia: A form of Strabismus in which one or both eyes turn outward. It is the opposite of crossed eyes, or Esotropia. Exotropia may occur from time to time (intermittent Exotropia) or may be constant, and is found in every age group (AAPOS, 2019).

Orthoptic Therapy: A series of exercises, usually weekly over several months, performed in the optometric office. Orthoptic eye exercises (orthoptics), as used by pediatric ophthalmologists and orthoptists, are eye exercises to improve binocular function and are taught in the office and carried out at home. Orthoptics is a well-established profession performed by orthoptists who work within the sub-specialty of ophthalmology. Orthoptists evaluate and measure eye deviations, manage Amblyopia treatment and treat small intermittent symptomatic eye deviations (AAPOS, 2020). Also referred to as Vision Therapy. The profession of orthoptics includes the evaluation and treatment of disorders of the visual system, particularly involving binocular vision and eye movement [American Association of Certified Orthoptists (AACO), 2018].

Strabismus: Misalignment of the eyes. Strabismus is most commonly described by the direction of the eye misalignment such as Esotropia, Exotropia, and hypertropia (AAPOS, 2020).

Vision Therapy: Optometrists define Vision Therapy as an attempt to develop or improve visual skills and abilities; improve visual comfort, ease, and efficiency; and change visual processing or interpretation of visual information. An optometric Vision Therapy program consists of supervised in-office and at home reinforcement exercises performed over weeks to months. In addition to exercises, lenses (“training glasses"), prisms, filters, patches, electronic targets, or balance boards may be used (AAPOS, 2020).

Applicable Codes

The following list(s) of procedure and/or diagnosis codes is provided for reference purposes only and may not be all inclusive. Listing of a code in this policy does not imply that the service described by the code is a covered or non-covered health service. Benefit coverage for health services is determined by federal, state, or contractual requirements and applicable laws that may require coverage for a specific service. The inclusion of a code does not imply any right to reimbursement or guarantee claim payment. Other Policies and Guidelines may apply.

CPT Code	Description
0687T	Treatment of amblyopia using an online digital program; device supply, educational set-up, and initial session
0688T	Treatment of amblyopia using an online digital program; assessment of patient performance and program data by physician or other qualified health care professional, with report, per calendar month
0704T	Remote treatment of amblyopia using an eye tracking device; device supply with initial set-up and patient education on use of equipment
0705T	Remote treatment of amblyopia using an eye tracking device; surveillance center technical support including data transmission with analysis, with a minimum of 18 training hours, each 30 days
0706T	Remote treatment of amblyopia using an eye tracking device; interpretation and report by physician or other qualified health care professional, per calendar month
92065	Orthoptic training; performed by a physician or other qualified health care professional
92066	Orthoptic training; under supervision of a physician or other qualified health care professional

Description of Services

For purposes of this policy, Orthoptic or Vision Therapy does not include the use of refractive treatment, such as refractive lenses.

Vision Therapy is also referred to or may include eye exercise therapy, Visual Therapy, visual training, vision training, Orthoptic Therapy, orthoptics, orthoptic Vision Therapy, or optometric Vision Therapy. It is a term used by optometrists and is defined as an attempt to develop or improve visual skills and abilities; improve visual comfort, ease, and efficiency; and change visual processing or interpretation of visual information. An optometric Vision Therapy program consists of a series of supervised in-office and at home reinforcement exercises performed over weeks to months (AAPOS, 2020).

Behavioral/visual perceptual therapy is a psychoeducational intervention intended to correct visual-motor or perceptual-cognitive deficiencies that are claimed to contribute to a delay in speech and language development in preschool children. It involves eye exercises to improve visual processing and perception (AAPOS, 2020).

Visual information processing evaluation (VIPE) identifies problems with the processing of information for enhanced school and/or social development. Visual processing refers to a group of skills used for interpreting and understanding visual information. The evaluation may include testing for visual spatial orientation skills, visual analysis skills, including auditory-visual integration, visual-motor integration skills, and rapid naming.

Clinical Evidence

Orthoptic Therapy or Vision Therapy (VT) for Treating Convergence Insufficiency (CI)

A 2023 Hayes Health Technology Assessment evaluated VT for treating children and younger adults with accommodative dysfunction with or without concomitant CI. The assessment concluded that there is an overall low-quality body of evidence indicating that VT is safe and expected to correct the symptoms and measures of accommodative dysfunction compared with baseline and alternative treatments. Some studies considered results beyond the end of VT to see if outcomes were sustained, and two studies gauged an individual's symptoms, with most counting on intermediate/surrogate results of accommodative function to assess success. In addition, there was a sizable variation in the precise indications for therapy and the types of VT provided. In the 2024, updated Hayes health technology assessment, there were no new relevant published studies that met the inclusion criteria set, and no change in the previous overall assessment. There is a need for additional well-designed studies to outline the modes and treatment schedules that would be most effective and address the comparative efficiency of VT with clinical alternatives.

In 2022, Li et al. conducted a pilot randomized controlled trial (RCT) to compare the effectiveness of virtual reality-based VT and office-based vergence/accommodative therapy in young adults with CI or accommodative dysfunction. Individuals were randomly assigned in a 1:1 ratio to participate in one of two groups, the virtual reality-based VT group, or the office-based vergence/accommodative therapy group. Both groups received 12 weeks (one hour a week) of VT. A subjective questionnaire-based assessment was performed at baseline and after six and 12 weeks of therapy, and binocular vision (BV) functions were also measured. After 12 weeks of treatment, 33 participants with CI and 30 with accommodative dysfunction completed the study. The study demonstrated significant improvements in both groups after 12 weeks of therapy with a Convergence Insufficiency Symptom Survey (CISS) score of ($F = 13.704$, $p < 0.001$), near point of convergence (NPC) ($F = 21.774$, $p < 0.001$), positive fusional vergence (PFV) ($F = 71.766$, $p < 0.001$), and near horizontal phoria ($F = 16.482$, $p < 0.001$). Furthermore, improvements in the monocular accommodative amplitude ($F = 22.154$, $p < 0.001$) and monocular accommodative facility ($F = 86.164$, $p < 0.001$). Between the two groups a statistically significant difference was seen in monocular accommodative facility ($F = 8.140$, $p = 0.009$), however not in other vergence and accommodative functions ($0.098 < p < 0.687$). The study's limitations included the lack of a placebo/sham control group, small sample size, and short follow-up. From the trial, the authors concluded that virtual reality-based VT significantly improved BV functions and symptoms for individuals with CI and accommodative dysfunction, suggesting the therapy as a new optional or additional treatment for young adults with these conditions (Included in the 2023 Hayes Technology Assessment).

Alvarez et al. (2020) conducted a double-masked, RCT to study the neuro mechanism of CI in (n = 50) adult participants. The participants were randomized into two groups. Group one received office-based vergence/accommodative therapy and group two received office-based placebo therapy (OBPT). Office-based therapy was administered by a trained therapist during a biweekly, 60-minute office visit. The participants were prescribed additional procedures to be performed at home for 10 minutes a day, three times per week during the duration of the therapy. Home therapy was to be conducted on days when office-based therapy was not conducted. The objective was for participants to attend two 60-minute therapy sessions per week for 6 weeks. The home therapy was all computer based through [Home Therapy System (HTS), visiontherapysolutions.net]. The HTS program was used for the vergence/accommodative therapy group and a custom designed HTS program was used by the placebo. Outcomes measured were near point convergence, PFV and self-reported symptoms through a CISS score. The mean NPC improved by 6.0 and 3.1 cm in both the office-based vergence/accommodative and OBPT groups. With a MD of −2.9 cm; 95% CI, −4.6 to −1.0 cm; $p < .01$. The mean PFV increased by 17.3 and 7.4Δ in both the office based vergence/accommodative and OBPT groups. With an MD of 9.9Δ; 95% CI, 4.9 to 16.0Δ; $p < .001$. The mean CISS score improved by 12.4 and 10.1 points in both the office-based vergence/accommodative and OBPT groups. With an MD of 2.3 points; 95% CI, −8.3 to + 4.6 points; $p = .56$. The authors concluded that after twelve one-hour sessions that the office-based vergence/accommodative therapy group outcomes were significantly more effective than group of OBPT for improving clinical outcomes of NPC and PFV in the participants. However, the CISS measurements were not significantly different between the two groups.

In a Cochrane Database Systematic Review and network meta-analysis (NMA), Scheiman et al. (2020) analyzed twelve RCTs that included both children and adults (n = 1289) with symptomatic CI. The study measured the effectiveness of non-surgical interventions for CI. The outcomes measured required both clinical measures of convergence to be normal and show a pre-specified degree of improvement. The seven interventions measured were as follows: (1) office-based vergence/accommodative therapy with home reinforcement; (2) home-based pencil/target push-ups; (3) home-based computer vergence/accommodative therapy; (4) office-based vergence/accommodative therapy alone; (5) placebo vergence/accommodative therapy or other placebo intervention; 6.0 prism reading glasses; and 7.0 placebo reading glasses. This systematic review and NMA found with a high-certainty of evidence that office-based vergence/accommodative therapy with home reinforcement increases the chance of a successful outcome, compared with home-based computer vergence/accommodative therapy [risk ratio (RR) 1.96, 95% CI 1.32 to 2.94], home-based pencil/target push-ups (RR 2.86, 95% CI 1.82 to 4.35); and placebo (RR 3.04, 95% CI 2.32 to 3.98). However, there was no evidence of any treatment difference between home-based computer vergence/accommodative therapy and home-based pencil/target push-ups (RR 1.44, 95% CI 0.93 to 2.24; low-certainty evidence), or between either of the two home-based therapies and placebo therapy to be considered effective treatment. The authors concluded that office-based vergence/accommodative therapy with home reinforcement is more effective than home based pencil/target push-ups or home-based computer vergence/accommodative therapy for children. The evidence is unclear in adults as to which of the therapies is more effective. The findings are limited by the indirect comparisons of NMA.

An RCT (CITT-ART Investigator Group, 2019) was designed to determine whether treating symptomatic CI would lead to better reading fluency and comprehension. Three hundred eleven children aged 9 to 14 years with symptomatic CI were randomly assigned to 16 weeks of office-based vergence/accommodative therapy or placebo therapy. Improvements in (1) NPC, (2) PFV, and (3) self-reported symptoms CISS score were compared after 16 weeks of treatment. The results showed mean NPC improvement of 10.4 cm in the vergence/accommodative group, and 6.2 cm in the placebo therapy, mean PFV increased 23.2 and 8.8 in the vergence/accommodative and placebo therapy groups, respectively as well as a mean CISS score improvement of 11.8 and 10.4 points in the vergence/accommodative and placebo therapy groups, respectively. The authors concluded that these results demonstrate that office-based vergence/accommodative therapy is effective for improving the NPC and PFV in children with symptomatic CI. However, given that both treatment groups had a similar reduction in self-reported symptoms, it may not be prudent to use the CISS alone as a measure of successful treatment (Included in the Scheiman et al. 2020 systematic review).

In a systematic review of the literature on orthoptic therapy for CI, Rucker & Phillips (2018) reported that convergence exercises reduce symptoms and improve signs of CI in otherwise healthy people. Those with learning disabilities (LD), poor reading ability, dyslexia, or Attention Deficit Hyperactive Disorder (ADHD) do not consistently have unique ocular motor deficits, nor do people who acquire ocular motor deficits develop these conditions, and there is insufficient evidence that shows treatment consisting of repetitive ocular motor tasks improves LD, reading, dyslexia, or ADHD. The most efficacious convergence tasks and the optimal duration and frequency of these tasks remain unknown.

The National Eye Institute sponsored the Convergence Insufficiency Treatment Trial (CITT) study was an RCT comparing the effectiveness of different treatment options for the condition in 221 children (age 9 to 17 years). Three types of VT were compared with a placebo therapy intervention. VT included: (1) office-based VT with at-home exercises; (2) home-based pencil push-ups with additional computer vision therapy (HBCVAT+); and (3) home-based pencil push-up (HBPP) therapy alone. The placebo therapy group was given placebo vision activities that simulated office-based therapy. The study found that after 12 weeks of treatment, nearly 75% of children who received office-based VT with at-home reinforcement achieved normal vision or had significantly fewer symptoms of CI. In comparison, only 43% of participants who completed home-based therapy alone showed similar results, as did 33% of those who used HBCVAT+ and 35% of people who underwent OBPT (Convergence Insufficiency Treatment Trial Study Group, 2008).

Remote, Online, and/or Digital Therapies or Vision Therapy (VT) for Amblyopia

Only limited quality clinical evidence was found to support the superiority of remote, online, or digital orthoptic or VT for amblyopia over conventional treatments. Existing studies are limited by single-arm design, insufficiently long follow-up for a chronic condition, and a large dropout rate.

Ming et al. (2025) conducted a systematic review and meta-analysis on perceptual learning and video game training for adults with monocular amblyopia to analyze the effectiveness of perceptual learning and video game training. To carry out the review, data on interventions, sample size, and log MAR visual acuity (VA) were extracted and analyzed. The review resulted in the identification of 6439 studies with 22 meeting the inclusion criteria. The analysis showed a statistically significant standardized mean difference (SMD) of -0.68 in the experimental group (EG) compared with controls, indicating an improvement in VA ($p < 0.05$). Subgroup analyses indicated that perceptual learning and video game training also resulted in visual improvement ($p < 0.05$). In addition, the results indicated a significant improvement in VA with dichoptic training or monocular training, reaching VA improvement ($p < 0.05$). The authors concluded that targeted

visual training facilities neural plasticity, reduces interocular suppression, and reinforces neural pathways associated with visual processing. This review is limited by the limitation of the included studies and the heterogeneity in device used. Future research that focuses on refining training protocols to enhance both monocular and binocular visual function most effectively is necessary.

In 2023, Hayes conducted an evolving evidence review on Luminopia One (Luminopia Inc.) for treating amblyopia in children. The review found minimal support from clinical studies, no/unclear support from systematic reviews, and weak support from guidelines for Luminopia One for treating amblyopia in children aged 4 to 7 years of age. Although Luminopia One may improve VA in children aged 4 to 7 years with amblyopia and be more appealing than patching and atropine which could lead to better treatment adherence, future studies are necessary to compare with the current standards of care, and post treatment VA. Additionally, the technology requires internet access and devices, which may be costly and can lead to possible treatment disparities. This review was updated in 2025 resulting in no newly published studies that may meet the inclusion criteria set out in the 2023 report.

In an ECRI clinical evidence assessment published in 2024, the CureSight System (NovaSight, Inc.) was explored for treating amblyopia. The publication concluded that CureSight is safe and may work as well as patching to improve VA at up to one-year follow-up for children with amblyopia, based on evidence from two RCTs and one pre-post study. However, the available studies are small, and added studies are necessary to support firm conclusions about how well CureSight works compared with patching. The existing studies report comparative outcomes at only short-term follow-up. Longer-term studies (e.g., ≥ three years) are needed to consider CureSight's permanent benefit and amblyopia recurrence. One ongoing trial is not likely to address evidence gaps due to the small sample size and single-arm design but will provide outcomes for individuals ages two through 20.

Tsani et al. (2024) explored the use of binocular digital therapy for amblyopia when compared to standard treatments or placebo therapy. The review comprised of randomized controlled trials (RCTs), including individuals with unilateral amblyopia who received binocular therapy or standard amblyopia or placebo treatment for more than two weeks and who had VA assessment pre- and post-treatment. The results of this exploration included 20 RCTs with 1769 individuals incorporated into the review. Two main types were identified: presentation of low-contrast images in the fellow eye, including stimuli presented only in the amblyopic eye and the second type combines the approach with complementary dichoptic deficits in the images presented to both eyes to encourage their simultaneous use. The authors concluded that binocular amblyopia treatment has shown promising results in addressing unilateral anisometropic, strabismic, or mixed type of amblyopia. Nevertheless, further RCTs are essential to prove the exact dosage, type, and duration of binocular therapy as a standard component of amblyopia care. (The following publications, discussed in more detail below, were reviewed as part of this systematic review: Manh et al., 2018; Pang et al. 2021; Roy et al. 2023; Herbison et al. 2016; Elhusseniny et al. 2021; Jost et al. 2022; Wygnanski-Jaffe et al. 2023; Kadhum et al. 2024).

Through an RCT, Kadhum et al. 2024 sought to compare the efficacy and effectiveness of supervised dichoptic action-videogame play to occlusion therapy in children with amblyopia. The trial, conducted after 16 weeks of refractive adaptation, involved participants who were randomized to gaming one hour a week and supervised or electronically monitored occlusion two hours a day. The primary outcome measured was VA change from baseline to 24 weeks. The results of the trial showed a median VA improvement by 0.30 logMAR (IQR 0.20-0.40) after gaming, 0.20 logMAR (0.00-0.30) after occlusion ($p = 0.823$). Treatment effectiveness was 1.25 logMAR/100 h (range 0.42-2.08) with gaming, 0.08 (-0.19-0.68) with occlusion ($p < 0.001$). The authors concluded that dichoptic gaming presents a promising and practical alternative for older children with refractive amblyopia after glasses adaptation. Treatment efficiency with gaming under continuous supervision was 15 times greater than with occlusion at home, offering a hopeful prospect for the future of amblyopia treatment. The findings are, however, limited by the large dropout rate and feasibility of researcher-supervised weekly gaming (Included in the 2024 systematic review by Tsani et al.).

In 2024, Wygnanski-Jaffe and associates set out to report the long-term outcomes of a noninferiority RCTs with a binocular eye-tracking-based home treatment (CureSight; Novasight, Ltd.) for those with amblyopia through a prospective, multicenter, nonrandomized, long-term follow-up observational study of an RCT. At 12 weeks post-treatment of the intervention group, improvement in amblyopic eye VA was retained vs. baseline (0.27 ±0.14 logMAR, $p < .0001$), with no change vs the end-of-treatment visit ($p > .05$). At one year there was a partial reduction in the amblyopic eye VA gain of 0.085 ±0.1 logMAR related to end-of-treatment ($p = .001$), but the residual gain of 0.20 ±0.14 logMAR compared to baseline was statistically significant ($p < .0001$). Gains in stereoacuity and binocular VA were maintained vs baseline at both 12-weeks and 1-year post-treatment ($p < .0001$), with no change vs end-of-treatment ($p > .05$). Amblyopia recurrence (a worsening of ≥ 2 logMAR levels compared with end-of-treatment) occurred in 2/38 people at 12-weeks post-treatment (5.3%), and in 5/27 people at 1-year post-treatment (20.4%). The authors concluded that VA and stereopsis gains after binocular treatment with CureSight were retained for one year without further treatment. The findings are, however, limited by lack of comparison groups.

In the 2023 prospective, multicenter, randomized, masked, controlled, noninferiority pivotal clinical trial conducted by Wygnanski-Jaffe and colleagues, the authors compared visual outcomes after the use of binocular eye-tracking based home treatment (CureSight; NovaSight Ltd) with patching. Children aged four to less than nine years with anisometropic, small-angle strabismic, or mixed-mechanism amblyopia (n = 103) were randomized 1:1 to a group getting either CureSight or patching treatment. In the CureSight group, the participants utilized the device for 90 minutes/day, five days/week for 16 weeks (120 hours), while the patching group received two hours of patching seven days a week for 224 hours. The primary outcomes measured were the improvement in the amblyopic eye VA, modeled with a repeated measures analysis of covariance, stereo acuity, binocular VA, and treatment adherence rates, which were evaluated by a 1-sample Wilcoxon test in each group and a 2-sample Wilcoxon test that compared the two groups. The safety results were calculated by the frequency and severity of the study-related adverse events (AE). The trial resulted in the CureSight group VA improvement found to be noninferior to the patching group improvement [0.28 ±0.13 logMAR ($p < 0.0001$) and 0.23 ±0.14 logMAR ($p < 0.0001$), respectively; 90% confidence interval (CI) of difference, -0.008 to 0.076]. Stereoacuity improvement of 0.40 log arcseconds ($p < 0.0001$) and improved binocular VA (0.13 logMAR; $p < 0.0001$) were observed in the binocular treatment group, with similar improvements in the patching group in stereoacuity (0.40 log arcseconds; $p < 0.0001$) and binocular VA (0.09 logMAR; $p < 0.0001$), with no significant difference between improvements in the two groups in either stereoacuity (difference, 0; 95% CI, -0.27 to -0.27; $p = 0.76$) or binocular VA (difference, 0.041; 95% CI, -0.002 to 0.085; $p = 0.07$). The binocular treatment group had a significantly higher adherence than the patching group (91% vs. 83%; 95% CI, -4.0% to 21%; $p = 0.011$). No severe AEs were found. The limitations of the study include most individuals having anisometropic amblyopia, lack of generalizability between strabismic and mixed amblyopia populations, and lack of evaluation on the impact of dosing for the rapidity of visual improvement, durability, and effect of subgroups for treatment effectiveness. The authors concluded that the binocular treatment was well tolerated after a 16-week trial period and showed higher regimen adherence rates and parent preferences, though non-inferior to patching for children with amblyopia. Improvements were seen in stereopsis and binocular VA (Included in the 2024 systematic review by Tsani et al.).

In 2023, Roy et al. performed a prospective, randomized, interventional study to evaluate smartphone-based dichoptic video games versus occlusion therapy for children with anisometropic amblyopia. Children aged 5 to 15 with anisometropic amblyopia were included in the study (n = 55) and randomized into two groups: the video game group (n = 27) and the patching group (n = 28). The video game group played a dichoptic video game with adjusted contrast for two hours a day, and the patching group received occlusion therapy of the non-amblyopic eye for six hours a day. The outcomes measured were the BCVA, near vision, contrast sensitivity (CS), and near and distance stereoacuity at baseline, at one, two, and three months. The study's results showed that the mean distance BCVA improved from 0.74 ±0.19 and 0.70 ±0.18 logMAR in the video game and patching groups, respectively, at baseline to 0.53 ±0.19 and 0.49 ±0.19 logMAR, at three months ($p < .001$ for both). The mean near vision was 0.82 ±0.19 and 0.81 ±0.17 logMAR in the video game and patching groups, respectively, at baseline and improved to 0.60 ±0.16 and 0.63 ±0.17 logMAR at three months ($p < .001$ for both). There was no sizable difference in distance and near vision among the two groups at baseline and the last follow-up visit. CS was 1.41 ±0.20 and 1.38 ±0.20 in the video game and patching groups, respectively, at baseline and 1.74 ±0.18 and 1.61 ±0.21 at three months ($p < .001$ for both). At the final follow-up visit, CS was better in the video game group compared to the patching group ($p = .01$). Near stereoacuity notably progressed only in the video game group ($p = .006$); in contrast, distance stereoacuity did not improve in either group. The limitations of the study include the small sample size and lack of long-term follow-up. The authors concluded that dichoptic video game therapy showed better outcomes in terms of improved CS and near stereoacuity and comparable results for distance and near vision compared to patching for children with anisometropic amblyopia. The accessibility of exciting games is necessary to support children's interests (Included in the 2024 systematic review by Tsani et al.).

In a systematic review and meta-analysis, Shao and colleagues (2023) sought to uncover how VR technology varies from conventional patching therapy's efficacy. The meta-analysis consists of eight studies and ten trials with 459 participants. The results of the review and analysis showed that overall, VR technology treatment considerably improved VA by 0.07 logMAR [95% confidence interval (CI), −0.11 to −0.02; $p < 0.001$; $I2 = 94.4\%$] versus traditional patching therapy. In addition, subgroup analyses also exposed that treatment with VR technology was more efficient when the child was younger than seven years old or when the intervention was no more than twenty hours. The studies limitations include a high degree of heterogeneity, lack of analysis on the effect of VR technology on stereo acuity, and the meta-analysis only included studies published in English. Furthermore, most included studies were of short duration (2-12 weeks), and it is unclear whether the observed benefit would be sustained after the initial interest of the child. The authors concluded that VR technology treatment substantially improved VA for children seven years of age or younger with amblyopia.

In a 2023 systematic review and meta-analysis, Yeh et al. investigated the efficacy of the Cambridge Stimulator with grating element stimulation of VA, grating acuity (GA), and CS for individuals with amblyopia. The search uncovered 1221 studies, with 24 of those studies encompassing 900 individuals included in the review. The results of the review suggested that the outcome measure of all visual indexes (VA: Hedges' g of -0.43, 95% CI = -0.81 to -0.05, I2 = 86%, p =

0.02; GA: Hedges' g of 3.79, 95% CI = 1.05 to 6.54, I2 = 98%, p = 0.01; CS: Hedges' g of 0.64, 95% CI = 0.19 to 1.09, I2 = 41%, p = 0.00) significantly favored in the grating group. The limitations of the study include high risk of bias and the lack of varying methodologies in the study designs. The authors concluded that grating stimulation may positively benefit visual functions for individuals with amblyopia.

In a retrospective interventional comparative study, 36 children with unilateral amblyopia were enrolled to determine the efficacy of VT for unilateral refractive amblyopia in children aged 7-10. For the study, the participants were divided into a case group and a control group. The case group received VT, optical correction, and part-time patching of the weaker eye, and the control group received optical correction and part-time patching of the weaker eye. Outcomes of VA were measured at baseline, three months, six months, nine-month visits, and three months after completion of treatment. The case group consisted of 19 individuals and 17 individuals in the control group. The study showed a mean improvement in the case group from 0.39 ±0.24 logMAR at baseline to 0.10 ±0.23 logMAR after treatment. The results for the control group demonstrated an improvement from 0.64 ±0.30 logMAR at baseline to 0.52 ±0.27 logMAR after treatment. All participants underwent follow-up examinations within six to 12 months, with no regression of VA seen in the case group three months after completion of therapy. Individuals in the case group who received VT demonstrated improved VA versus those who received optical correction and patching. A limitation of the study is the retrospective design which restricts the ability to control and randomize the participants into case and control groups. The authors concluded from the study that for children aged 7-10 with unilateral refractive amblyopia, VT combined with conventional treatment such as optical correction and part-time patching are more effective than traditional treatment alone. Furthermore, the therapy provided more significant vision gain and a shorter duration of treatment when compared to conventional treatment (Hsieh et al., 2022).

In a retrospective comparative study, individuals aged 7-10 years were enrolled to determine the effects of VT on bilateral amblyopia unresponsive to conventional treatment. The control group consisted of 16 cases with age and VA-matched bilateral amblyopes; 15 cases were included in the treatment group. The study showed no improvement in either group for VA for more than three months with part-time patching and full refraction correction. Of 22 eyes, 68.7% showed no improvement in the control group versus the treatment group, which exhibited better VA in every eye. The treatment group revealed significant improvement in BCVA, with an average gain of 0.32 ±0.15 logMAR vs. 0.003 ±0.19 logMAR in the control group. The benefits of treatment are most significant in the first three months of treatment and continue until the endpoint. Results of stereoacuity showed improvements from 190.00 ±163.34 to 85.00 ±61.24 arc seconds (a 55.26% improvement). The limitations of the study are the retrospective design, which restricts the ability to randomize participants, small sample size, and lack of complete stereoacuity data. The authors conclude that a VT program comprising orthoptic therapy, perceptual learning, and dichoptic training successfully increases VA and stereoacuity in 7-10-year-old individuals with bilateral amblyopia that is unresponsive to conventional treatment (Huang et al., 2022).

In 2022, Jost et al. conducted an RCT to evaluate the effectiveness of dichoptic movies versus patching for treating amblyopia in children aged three to seven. After inclusion and exclusion criteria were met, 65 children were considered eligible, and enrolled in the trial, and 60 participants completed the study through the four-week visit. Children were randomized to a movie group and a patching group. During the first two weeks, the movie group watched 5.7 ±0.7 movies, and the patching group averaged 30.0 ±11.0 hours of patching. At the two-week primary outcome visit, the movie and patching groups had similar improvement in amblyopic eye BCVA (0.07 vs. 0.06 logMAR). Treatment with movie and patching significantly improved VA (0.07 ±0.05 logMAR and 0.06 ±0.05 logMAR, respectively). VA continued to advance in the movie group after the two-week primary outcome visit, with enhancements of 0.13 ±0.11 logMAR by four weeks and 0.15 ±0.10 logMAR by six weeks. The patching group exhibited comparable improvements after crossing over to movies at two weeks. By week eight, the patching group who crossed over at two weeks gained 0.18 ±0.07 logMAR. The choice to remain in the movie treatment past the four weeks visit for up to six weeks of the movie treatment was chosen by 35 (58%) participants. After six weeks of watching contrast re-balanced dichoptic movies (six-week visit for the movie group and eight weeks visit for the patching group), 26% of children had ≤ 0.1 logMAR interocular difference in VA. The authors concluded that the at-home binocular movie treatment effectively improves amblyopic eye BCVA. Additional improvements were seen with up to six weeks of treatment, making repeated binocular visual experience with contract re-balanced dichoptic movies an additional treatment option for amblyopia. Limitations of the study include short treatment duration, the difference in VA tests, and lack of objective adherence monitoring (Included in the Shao et al. 2023, and Tsani et al. systematic reviews).

Xiao et al. (2022) evaluated the safety and efficacy of a dichoptic digital therapeutic for amblyopia. This phase three RCTs consisted of 105 children aged four to seven with amblyopia and enrolled at 21 academic and community sites in the United States. Individuals were randomized to the treatment or comparison group in a 1:1 ratio and stratified by site. The treatment group consisted of 51 participants and 54 in the comparison group. Individuals in the comparison group continued to wear glasses on a full-time basis while the treatment group used the therapeutic at home for one hour a day, six days a week, and wore glasses full-time. To determine efficacy, the change in amblyopic eye VA from baseline to 12

weeks was measured by masked examiners. The authors evaluated the frequency and severity of study-related AEs (anticipated and unanticipated) to determine the therapy's safety. The intention-to-treat population was utilized to develop a primary analysis. In the treatment group at 12 weeks, amblyopic eye VA improved by 1.8 lines (95% CI, 1.4-2.3 lines; n = 45); and in the comparison group, there was an improvement of 0.8 lines (95% CI, 0.4-1.3 lines; n = 45). The difference between groups was significant 1.0 line (0.10 logMAR; 96.14% CI, 0.33-1.63 lines; p = 0.0011). Individuals sustained high adherence to the therapeutic throughout the study, and adherence was associated with overall satisfaction. No serious AEs were reported, and the study was stopped early per protocol due to success. Limitations include the lack of comparison between patching and atropine penalization, short follow-up time, and risk of bias. The authors support the value of the therapeutic in clinical practice as an effective treatment. Additional independent studies with longer follow-up and sham interventions are warranted to confirm the long-term value of this approach over or in addition to standard treatments (Included in the Shao et al. 2023 and Tsani et al. systematic reviews).

In 2021, Roda et al. conducted a systematic review and meta-analysis of RCTs to summarize the available evidence to determine if binocular treatment is more effective than patching in children with amblyopia. VA and stereopsis were assessed as primary outcome measures. Out of five RCTs, no significant difference in VA between individuals treated with binocular treatment and patching was demonstrated at -0.12 (95% CI: -0.45-0.20; p = 0.464). Additionally, no significant difference in stereopsis was found between individuals treated with binocular treatment versus patching -0.07 (95% CI: -0.61-0.48; p = 0.809). Limitations to the study include the high heterogeneity in effect estimation, inconsistency between studies, and the lack of consideration regarding cost and availability of treatment. The authors concluded that this meta-analysis uncovered no substantial evidence that supports the efficacy of binocular therapy as an alternative to traditional patching. Although binocular treatment can be considered a good complementary therapy in particular cases, it cannot fully replace conventional treatment. The following publications, discussed in more detail below, were reviewed as part of this systematic review: Manh et al., 2018; Rajavi et al., 2019.

Elhusseiny et al. (2021) conducted a pilot, prospective, randomized, double-masked, crossover clinical trial at a single center site using (n = 20) children and young adult participants. The participants had unilateral anisometropic and/or strabismic amblyopia with amblyopia treatment failure. Eleven participants underwent eight weeks of binocular treatment using a VR headset that contained a therapeutic software application. The sham-crossover group (n = 9) underwent four weeks of sham treatment followed by four weeks of binocular treatment. Both groups underwent one hour of treatment per day. Participants and clinicians were masked to prescribed treatment. The devices were loaned to the participants and devices used were Apple iPhone 6 Plus smartphone, preloaded with the prototype therapeutic software, and a Zeiss VR One Plus VR headset that delivered the visual input to each eye dichotically. Outcomes in the full-treatment group (n = 11), the mean amblyopic eye logMAR VA at 16 weeks was 0.49 ±0.26, compared with 0.47 ±0.20 at baseline. Compared to the sham-crossover group, it was 0.51 ±0.18 at 16 weeks, compared with 0.53 ±0.21 at baseline. Stereoacuity (log arcsec) was significantly improved, from 7.3-2 at baseline to 6.6-2.3 at 8 weeks (p < 0.001) and 6.7-2.6 at 16 weeks (p < 0.001). No significant AEs (diplopia, asthenopia, or worsening strabismus) were noted in either group. The authors concluded that virtual reality-based prototype binocular amblyopia therapy did not significantly improve VA. Stereoacuity did improve compared to baseline measurements when all participants were combined. The study is limited by its small sample size and short follow-up. The authors report that they did not achieve the target sample size due to participant attrition (Included in the Shao et al. 2023, and the Tsani et al. 2024 systematic reviews).

Birch et al. (2020) conducted an RCT with (n = 48) children diagnosed with amblyopia. The children were randomly divided into two groups. Group one (n = 24) received binocular amblyopia game treatment for one hour a day, five days a week. Group two (n = 24) received patching treatment for two hours per day, seven days a week. The outcomes measured were changes in the amblyopic eye best-corrected VA at the two-week visit. Baseline factors examined were age at enrollment, VA, stereoacuity, and suppression. At baseline, the mean amblyopic eye best-corrected VA ±standard deviation (SD) was 0.49 ±0.16 logMAR (~20/63 ±1.6 lines); range = 0.3-0.8 logMAR (20/40-20/125). VA was 0.3-0.6 logMAR (20/40-20/80) in 38 (79%) children and 0.7-0.8 logMAR (20/100-20/125) in 10 (21%) children. After two weeks, the measurements for group one, who received binocular amblyopia game treatments showed improvement which ranged from 0.0 to 0.4 logMAR; 21 children (87.5%, CI 95% = 69%-96%) improved by 0.1 logMAR or more (2 improved 0.3-0.4 logMAR, 10 improved 0.2 logMAR, 9 improved 0.1 logMAR), and three children did not improve (12.5%, CI 95% = 4%-31%). Group two, who received patching treatment, showed improvement which ranged from −0.1 to 0.2 logMAR; 12 children (50%, 95%CI = 31%-69%) improved by 0.1 logMAR or more (5 improved 0.2 logMAR, 7 improved 0.1 logMAR), and 11 children (46%, CI 95% = 28%-65%) did not improve, and one child (4%, CI 95% = 1%-20%) decreased by −0.1 logMAR. At the 2-week visit, 35% (95%CI: 19% -55%) of children playing the binocular game recovered normal VA for age (≤ 0.2 logMAR; 20/32 or better). Only 8% (CI 95% = 2% -26%) of the children in the patching group had recovered normal VA for age at the 2-week visit. The authors concluded that after two weeks of treatment, VA improvement was significantly greater with the binocular game treatment than patching. Children with moderate amblyopia and orthotropia had more VA improvement with binocular game play than those with severe amblyopia. Limitations of this trial include

small sample size, short time duration, and inability to monitor the number of hours of patching objectively. Authors relied on a calendar log completed by their parents.

Rajavi et al. (2019) conducted an RCT with 38 children diagnosed with unilateral amblyopia who received amblyopia therapy via interactive binocular treatment (I-BiT™) and others received standard patching of the dominant eye with a placebo I-BiT. Children who had BCVA less than 20/30 (0.3 logMAR) in one eye or a difference of two lines of Snellen between their two eyes were included in this study and randomly divided into the case study group (n = 19) and control group (n = 21). The case study group was recommended to play the I-BiT games using red-green glasses, 20 to 30 minutes per day for at least five days a week for one month (total hours = 6). The control group underwent two -and four-hour patching of dominant eye per day and to play I-BiT games with no red-green glasses, 20 to 30 minutes per day for at least five days a week for one month. The authors concluded that BCVA improved significantly in both groups after one-month treatment (case: $p = 0.003$, control: $p < 0.001$). There was not a significant difference between the two groups ($p = 0.52$). Stereopsis improved in the case study group by ($p < 0.001$) and control group by ($p < 0.001$), but they did not identify large difference between the two groups pre -and post-therapy. The children engaged in playing I-BiT games for six hours total during one month in both groups. Compliance in the case study group was 87.5% and 76% in the control group. Limitations of this study include a small sample size, the short study duration, and lack of monitoring for recurrence of decreased BCVA. Additionally, some participants were excluded after randomization due to lack of compliance, which could introduce biases in the findings (Included in the Shao et al. 2023, and the Tsani et al. 2024 systematic reviews).

Manh et al. (2018) conducted an RCT to compare VA improvement of 100 participants aged 13 to < 17 years (mean 14.3 years) with amblyopia who were treated with either part-time eye patching or a binocular game on a tablet device. Participants were randomly assigned to treatment for 16 weeks of either the binocular game prescribed for 1 hour per day (n = 40) or patching of the fellow eye prescribed for 2 hours per day (n = 60). The main outcome measured was a change in amblyopic eye VA from baseline to 16 weeks. Mean amblyopic eye VA improved from baseline by 3.5 letters (2-sided 95% CI: 1.3-5.7 letters) in the binocular group and by 6.5 letters (2-sided 95% CI: 4.4-8.5 letters) in the patching group. After adjusting for baseline VA, the difference between the binocular and patching groups was -2.7 letters (95% CI: -5.7 to 0.3 letters, $p = .082$) or 0.5 lines, favoring patching. In the binocular group, treatment adherence data from the device indicated that only 13% of participants completed > 75% of prescribed treatment. In this population, eye patching was favored over the binocular group; however, it remains unclear whether the minimal response to binocular treatment was due to poor treatment adherence or lack of treatment effect (Included in the 2024 systematic review by Tsani et al.).

In 2016, Herbison et al. conducted a three-arm RCT that was performed on children with Amblyopia. The (n = 75) children were randomized and assigned one of three treatments I-BiT game (n = 26), Non-I-BiT game (n = 25) and I-BiT digital video disc (DVD) (n = 24). The I-BiT game being used is VR technology that uses either DVD footage or computer games that present a common background for both eyes and a foreground that contains imagery of interest for the amblyopic eye only. The assigned groups received treatment for 30 minutes weekly for six weeks. The primary outcome is the difference in VA between the group treated with I-Bit game versus non-I-Bit game which I measured by using a logMAR VA test at pretreatment (baseline), and after three, six and final treatment over 10 weeks. The secondary outcomes included changes in stereoacuity (Frisby test), safety, acceptability, and compliance during treatment. The authors concluded that modest VA improved in all three arms by approximately 0.07 logMAR in the amblyopic eye at 6 weeks. There was not a significant difference between I-BiT DVD and non-I-BiT games compared with I-BiT games in terms of improvement of vision. The limitations of the trial are short treatment times, trial was hospital based during work and school hours with limited the duration and frequency of treatment sessions, a high number of participants with previous amblyopia treatment failures, and a high number of participants with strabismus created disadvantages for dichoptic stimulation. An adverse effect reported of diplopia which led to decreased VA and participant withdrawal from the trial. Further, I-BiT game multi-center and longer duration studies are needed with the amblyopic population. Lack of comparison with conventional amblyopia therapy is another limitation of this study (Included in the Shao et al. 2023, and Tsani et al. 2024 systematic reviews).

Vision Therapy (VT) for Convergence Excess or Nystagmus

No well-designed clinical trials evaluating the use of vision therapy for convergence excess or nystagmus were identified.

Vision Therapy (VT) for Divergence Excess or Insufficiency

No well-designed clinical trials evaluating the use of vision therapy for divergence excess or divergence insufficiency were identified.

Orthoptic or Vision Therapy (VT) for Exotropia or Esotropia

Only limited quality clinical evidence was found to support the use of orthoptic or VT for exotropia. Existing publications are limited by post hoc analyses, lack of long-term follow-up, and inconclusive findings.

Through an RCT, Ma et al. (2024) evaluated the short-term effects of office-based vergence and anti-suppression therapy (OBVAT) on the office control score when compared to observation alone in children with small-to-moderate angle intermittent exotropia (IXT). The results of the trial showed that at the primary outcome visit, the OBVAT group (n = 20) had a significantly better distance Office Control Score (adjusted mean difference: -0.9; 95% CI: -0.2 to -1.5; p = 0.008; partial eta squared: 0.19) than the observation group (n = 16). Participants from the OBVAT group were likelier than those from the observation group to have ≥ 1 point of improvement at the 17-week visit (OBVAT group: 75%; Observation group: 25%; p = 0.006). The authors concluded that the OBVAT group had a significantly better distance Office Control Score than the observation group at the 17-week visit. This study provides the first data from an RCT demonstrating the effectiveness of OBVAT in improving the control of IXT. The findings are limited by the lack of long-term follow-up.

In An RCT by Liang et al. (2023), the authors assessed the effectiveness of binocular vision training (BVT) and Fresnel press-on prism (FPP) for children with esotropia combined with amblyopia. Registered for the trial were children aged 3-9 years with esotropia and amblyopia (n = 101). Two random groups were formed, the combined group (n = 48) and the prism group (n = 53). The children in the prism group received FPP treatment, while those in the combined group received a combination of therapy, BVT, and FPP. The primary outcomes measured were the VA, binocular function, and strabismic therapeutic effects. The results demonstrated a sizable improvement in both groups for VA versus before treatment (p = 0.0079). The binocular-monocular function, plus synoptophore visual function and the Titmus stereopsis, in both groups, was significantly better compared with those before treatment (p < 0.05), and it was more substantial in the combined group versus the prism group (p < 0.05). The cure rate of strabismus was 87.50% (42/48) and 30.19% (16/53) in the combined group and the prism group, respectively, and there was a significant difference between groups (p = 0.0036). The cure time decreased with the lower degree of esotropia. The study is limited by the small sample size. Larger, multi-center, and multi-disciplinary, high-quality research should be performed for further investigation. The authors concluded that BVT combined with FPP can efficiently promote the healing of BV in children with esotropia combined with amblyopia, and some children can attain a complete cure for strabismus.

Through an RCT, Zhang et al. 2023 investigated the effect of VR technology on children after surgery for concomitant strabismus. Included in the trial were 200 children with concomitant exotropia or concomitant esotropia who were randomly divided into two groups: the training group (n = 100) and the control group (n = 100). In the training group, participants received VR intervention training within a week after surgery. Those in the control group did not receive training. The results of the trial demonstrated that six months after the surgery, the orthophoria (the far or near strabismus degree was ≤ 8Δ) rate was meaningfully higher in the training group than in the control group (p = 0.001). In contrast, the eye position regression rate (versus the strabismus degree within one-week post-surgery, the amount of regression > 10Δ) was notably lower in the training group versus the control group (p = 0.001). Six months post-surgery, the number of children with simultaneous vision and remote stereovision was substantially higher in the training group compared to the control group (p = 0.017 and 0.002, respectively). The differences in the quantity of children with peripheral stereopsis, macular stereopsis, and stereopsis in macular fovea centralis at one, three-, and six-months post-surgery among the training and the control groups were not statistically significant (p = 0.916, 0.274, and 0.302, respectively). The authors concluded that the intervention of VR technology after strabismus correction efficiently enhanced children's visual function and cure rate post-surgery and sustained their eye position.

In a 2023 meta-analysis of RCT, Song and associates sought to compare the efficiency of PTO and the observation of intermittent exotropia (IXT) therapy. The exploration uncovered four articles with 617 individuals that could be included in the meta-analysis. The pooled outcomes exhibited PTO with higher effects versus observation, with more substantial reduction in exotropia control at distance and near (MD = 0.38, 95% CI: -0.57 to -0.20, p < 0.001; MD = -0.36, 95%CI, -0.54 to -0.18, p < 0.001), those subjected to PTO therapy had a more noteworthy reduction in distance deviations (MD = -1.95, 95% CI: -3.13 to -0.76, p = 0.001). And there was a more substantial increase in near stereoacuity among the PTO group versus the observation group (p < 0.001). The limitations of the study include a limited number of participants included leading to possible selection bias, limited data from included studies, and different classes of deviation control scale contributing to clinical heterogeneity. The authors concluded that PTO improved control and near stereopsis and reduced distance exodeviation angle of children with IXT compared with observation. PTO therapy is superior to observation for improving stereopsis at near. Studies are necessary to investigate if the advantage of PTO treatment is stable after the completion of therapy, the relationship between compliance and treatment results, and the effect of increasing occlusion duration on results.

In a 2023 RCT, Hatt et al. evaluated the effect of part-time patching versus observation on distance exodeviation control in a post hoc analysis of 3- to < 11-year-olds with IXT formerly reported in an RCT. This trial analyzes 306 participants who, at a distance fixation, naturally manifested either a constant or IXT or had continued recovery after monocular occlusion at baseline. The authors measured the change in control at distance and near fixation, from baseline to three months and baseline to six months. The results showed a more significant improvement in the distance control score with patching than with observation at three months (MD, 0.4 points; 95% CI, 0.1-0.7) and six months (MD, 0.3 points; 95% CI,

0.02-0.6). The limitations of this trial consist of the analyses being conducted post hoc with 75% of the cohort for which treatment group differences in distance exodeviation control did not achieve statistical significance. Additionally, multiple comparisons were made, which can cause a greater likelihood that some are significant by chance. The authors concluded that part-time patching may result in improved distance control and reduced exodeviation in this subgroup of children. Due to the post hoc nature of the analysis, added studies are required to confirm the above results and decide the sustainability of the results.

In a Cochrane Database Systematic Review, Pang et al. (2021) analyzed the effects of various surgical and non-surgical treatments located in RCTs consisting of individuals with IXT. Additional aims of the review were to report intervention criteria and determine whether the treatment effect varies by age and subtype of IXT. The exploration uncovered six RCTs with a total of 890 individuals with basic or distance IXT. A meta-analysis of two RCTs comparing patching (n = 249) with active observation (n = 252) was completed. Further meta-analysis could not be undertaken due to clinical and methodological heterogeneity in the remaining trials. The evidence shows patching was clinically more effective than active observation for improving motor alignment at near and distance fixation. The results were measured by a prism and alternate cover test (PACT) at six months; results for patching: MD−2.23, 95% CI −4.02 to −0.44, and for active observation, MD −2.00, 95% CI −3.40 to −0.61. The results showed little to no difference in stereoacuity at near fixation (MD 0.00, 95% CI −0.07 to 0.07). The authors concluded from the evidence that patching offers a clinical benefit in children 12 months to 10 years of age who have basic or distance-type IXT compared with active observation. From the literature, there is not enough evidence to determine if interventions such as bilateral lateral rectus recession (BLR) vs. unilateral rectus recession with medical rectus resection; PAT before eye muscle surgery versus eye muscle surgery alone; and lateral rectus recession and medial rectus plication versus lateral rectus recession and medial rectus resection offer any benefit.

Feng et al. (2021) conducted an RCT in 60 participants with IXT to determine the efficacy of using over minus lenses combined with prisms to improve control of IXT. Group one (n = 30) was the observation group, and they wore lenses if refractive error met any of the following criteria: spherical equivalent (SE) anisometropia ≥ 1.00 D; astigmatism ≥ 1.00 D in either eye; or SE hyperopia ≥ + 1.00 D. Group two (n = 30) was treatment group, and they were prescribed over minus lenses of -2.50 D combined with the two prism diopters (PD) base-in prism on each side. Any participant who did not need refractive correction was prescribed Plano lens to be worn at each follow-up visit, but not to be worn during the trial. Ocular alignment, status of BV, and refraction were measured at one, three, six, and 12 months for both groups. After 12 months, the mean refractive error was 1.42 ±1.25 D, and 1.43 ±1.12 D for the observation and the treatment group, with a (95% CI: − 0.61 to 0.62)); the mean exotropia control score was 5.72 ±1.28 and 1.75 ±1.18 in the observation and the treatment group, with a (95% CI: − 4.63 to -3.33); the mean near stereoacuity was 2.16 ±0.42 log arcsec and 1.91 ±0.26 log arcsec in the observation and the treatment group, respectively (95%CI: − 0.44 to -0.06). The authors concluded that over minus lenses combined with prisms significantly improved the control of IXT and stereopsis. It reduced the angle of strabismus in children with IXT. Limitations of the study include small population size and no long-term monitoring after treatment to see control of IXT remains.

Shin et al. (2017) conducted a retrospective review to determine the effect of preoperative part time occlusion (PTO) therapy on long-term surgical success in early-onset exotropia in 51 consecutive participants. The mean duration of preoperative occlusion therapy was 10.2 ±5.4 months (range, 6 to 28 months). The mean follow-up duration after surgery for exotropia was 78.0 ±28.1 months (range, 36 to 135 months). Overall, the final success rate of surgery for early-onset exotropia was 66.7%. Five participants (9.8%) showed persisting consecutive esotropia and eventually underwent surgical correction for these consecutive esotropia at a mean age of 18.8 months (range, 8 to 40 months) after the primary surgery for exotropia. A higher long-term success and lower recurrence rate was found in those who were deemed as compliant (≥ 0%) than in the group of people who were deemed to be non-compliant (< 0%). These findings are limited by the observational design of the study.

Joyce et al. (2015) conducted a systematic review of RCTs, quasi-experimental and cohort studies with a comparison group examining interventions for divergence excess, simulated divergence excess or basic type exotropia in children, up to and including 18 years of age, followed for at least 6 months. Eleven studies satisfied the eligibility criteria. Seven examined the comparative effectiveness of two surgical procedures: four compared surgeries with other interventions, including botulinum toxin A therapy, orthoptic exercises, occlusion, BV training and watchful waiting. The evidence retrieved was of limited extent and quality with differences across studies in terms of outcome assessment and the most appropriate time-point for measuring long-term outcomes. There were mixed outcomes when comparing unilateral recession/resection (R&R) with BLR on improving angle of deviation, which makes it difficult to recommend either surgical option with confidence. While non-surgical interventions appear less effective in terms of improving angle of deviation, they are rarely associated with adverse outcomes. The authors concluded that given the limited evidence base, better designed studies are required to address the question of the most effective management for treatment of childhood exotropia. Importantly, consensus is required on what constitutes a successful outcome as well as agreement on how this should be measured.

An RCT was designed to compare part-time patching with observation for previously untreated IXT in children 12-35 months old (n = 201). Participants were randomly assigned to either observation (no treatment for 6 months) or patching prescribed for 3 hours daily for 5 months, followed by 1 month of no patching. The authors reported deterioration (defined as constant exotropia measuring at least 10Δ at distance and near or receipt of non-protocol treatment for IXT over 6 months was uncommon, with or without patching treatment. There was insufficient evidence for the authors to recommend part-time patching for the treatment of IXT in children in this age group (Mohney et al., 2015).

Buck et al. (2012) investigated the current patterns of management and outcomes of intermittent distance exotropia in an observational cohort study which recruited 460 children aged < 12 years of age with previously untreated distance exotropia. The data collected included angle, near stereoacuity, VA, control of distance exotropia measured with the NCS, and treatment. The main outcome measures were change in clinical outcomes in treated and untreated distance exotropia, 2 years from enrolment (or, where applicable, 6 months after surgery). At follow-up, data were available for 371 children (81% of the original cohort). Of these, 53% (195) had no treatment; 17% (63) had treatment for reduced VA only (pure refractive error and amblyopia); 13% (50) had no- surgical treatment for control (spectacle lenses, occlusion, prisms, exercises) and 17% (63) had surgery. Only 0.5% (2/371) of children developed constant exotropia. The surgically treated group was the only group with clinically significant improvements in angle or NCS, but rates of overcorrection were high. Non-surgical treatment of intermittent distance exotropia had less significant impact on angle of deviation or scores on the NCS.

Orthoptic or Vision Therapy (VT) for Stroke and Traumatic Brain Injury

Only limited quality clinical evidence was found to support the use of orthoptic or VT for stroke and traumatic brain injury. Limitations of the literature included conflicting findings and a lack of high-quality study design.

Namgung et al. 2025 conducted a multicenter RCT on personalized visual perceptual learning digital therapy for visual field defects following a stroke to evaluate the efficacy and safety of a personalized digital therapeutic based on visual perceptual learning for treating post stroke visual field defects (VFDs). The trial included poststroke outpatients 19 years or older with persistent VFDs (> 3 months after stroke) and neuroimaging-confirmed stroke lesions in the visual pathway. The training group underwent personalized visual discrimination tasks (orientation and rotation) using a mobile virtual reality headset 5 days a week for 12 weeks, with 360 trials per day. The control group received no intervention. The primary outcome measured was improved visual areas (defined as sensitivity increased by ≥ 6 decibels [dB] for 12 weeks) assessed using Humphrey visual field tests at baseline and 12 weeks. The results showed that as primary measures, the training group, with a high adherence rate, showed significantly greater improvement (sensitivity increased by ≥ 6 dB) in the whole field (median difference, 72 [95% CI, 36-108] degrees squared; p = .003; mean [SD], 194.1 [197.3] vs 82.5 [95.0] degrees squared) and defective hemifield (median difference, 72 [95% CI, 36-108] degrees squared; p = .002; mean [SD], 158.9 [159.0] vs 72.0 [91.4] degrees squared) compared with the control group. As secondary measures, mean (SD) Humphrey visual field test scores improved after 12 weeks in the training group but not in the control group. The authors concluded that in this RCT of a digital therapeutic for chronic poststroke VFDs, the visual perceptual learning-based training showed significant improvements in the whole field and defective hemifield. The study is limited by primary analyses focused on adherent participants and short follow-up.

Namgung et al. 2024 conducted a double-blind, multicenter, RCT to investigate the efficacy and safety of virtual reality-based visual perceptual learning for visual field defects in stroke. To conduct the trial, outpatients with stroke and VFDs (> 6 months after stroke onset) were randomized into NV (defective field training) or Nunap Vision-Control (NV-C, central field training) groups. Both interventions provided visual perceptual training, consisting of orientation, rotation, and depth discrimination, through a VR head-mounted display device five days a week for 12 weeks. The two groups received VFD assessments using Humphrey visual field (HVF) tests at baseline and 12-week follow-up. The final analysis included those who completed the study (NV, n = 40; NV-C, n = 35). Efficacy measures included improved visual area (sensitivity ≥ 6 dB) and changes in the HVF scores during the 12 weeks. The results of the trial demonstrated that with a high compliance rate, NV and NV-C training improved the visual areas in the defective hemifield (> 72 degrees²) and the whole field (> 108 degrees²), which are clinically meaningful improvements despite no significant between-group differences. According to within-group analyses, mean total deviation scores in the defective hemifield improved after NV training (p = .03) but not after NV-C training (p = .12). There are limitations to this trial, and future larger studies that provide eye tracking objective measures of training and compliance, visual measures other than luminance detection, and sham training as the control are warranted to support the study findings. The authors concluded that the current trial suggests that VPL-based digital therapeutics may induce clinically meaningful visual improvements in those with poststroke VFDs. Yet, between-group differences in therapeutic efficacy were not found as NV-C training exhibited unexpected improvement comparable to NV training, possibly due to learning transfer effects.

In a 2022 RCT, Batool et al. examined the effects of visual scanning exercises and a task-specific approach on balance and ADL for individuals post-stroke with eye movement disorders. Recruitment of 64 individuals took place where the

participants were randomized into either an experimental (n = 32) or a control group (n = 32). The EG was treated with visual scanning exercises and a task-specific approach, and the control group was treated with a task-specific approach alone. The outcomes measured were pre- and post-balance and ADL assessed on the Berg balance scale and Barthel index scale at baseline and the fourth week. The trial results demonstrated an Intra-group analysis of BERG BALANCE SCALE in the EG and showed statistically significant results ($p < 0.05$) in all items except items four, 13, and 14, respectively. Intra-group analysis of BERG BALANCE SCALE in the control group showed statistically significant results ($p < 0.05$) in items three, five, eight, and 12, respectively, while all remaining items showed statistically insignificant results. Intra-group analysis of BARTHEL INDEX SCALE in the EG showed statistically significant results in all items ($p < 0.05$) except in items nine and 10, respectively. Intra-group analysis of BARTHEL INDEX in the control group showed statistically significant results ($p < 0.05$) in items one, three, four, and eight, respectively, while all outstanding items showed statistically insignificant results. Inter-group analysis displayed statistically significant findings in total scores of BERG BALANCE SCALE ($p = 0.000$) and BARTHEL INEX SCALE ($p = 0.033$). The limitations of the study include small sample size and the lack of assessment of both therapies at follow-up. The authors concluded that visual scanning exercises and task-specific approach were more effective than a task-specific approach alone. Visual scanning exercises and a task-specific approach can be used to train balance and ADLs for individuals with stroke and eye movement disorders.

Qiu et al. (2021) performed a meta-analysis of seven RCTs including (n = 211) participants reviewing the efficacy of PA treatment in unilateral neglect post-stroke. Of the seven studies included, one study investigated the effects of PA in acute post-stroke neglect, and another study examined the chronic stage of stroke rehabilitation. Four studies reviewed terminal PA, two studies reviewed concurrent PA, and another singular study reviewed both treatments combined. Only one trial used no goggles as the control treatment, but neutral goggles (sham adaptation) were used in control groups of other studies. Visual deviation toward the right varied from six to twelve degrees. One trial adopted prism goggles with 11.4-degree rightward shift of visual field, and other trials used the goggles with 10-degree rightward deviation. The duration of PA treatment ranged from four days to four weeks, and most of the studies conducted two weeks of treatment. The results of the present meta-analysis show that PA did not have significant short-term or long-term beneficial effects which showed significant improvement in neglect symptoms of people with unilateral stroke. These outcomes were measured by using the Behavioral Inattention Test (BIT) or Catherine Bergego Scale (CBS) and compared with neutral goggles (sham adaptation) and standard care alone (no adaptation). The results were highly consistent and evaluated by the I^2 statistic ($I^2 \leq 15.9\%$) between studies regardless of the variability in treatment duration, type of PA, parameter of visual shift, and follow-up duration. The authors concluded that the application of PA, compared to using a placebo or no treatment, lacked significant data which demonstrated much improvement in neglect symptoms of participants diagnosed with unilateral post-stroke. The meta-analysis and systematic review findings do not support routine use of PA therapy for unilateral post-stroke participants.

Cavanaugh et al. (2020) published the results of an RCT evaluating the efficacy of motion discrimination training as a potential therapy for stroke-induced hemianopia visual field defects. Forty-eight subjects with stroke-induced homonymous hemianopia were randomized into two training arms, an intervention, and a control. The subjects were between 21-75 years of age and presented with no ocular issues. Subjects were randomized with equal allocation to receive training in either their sighted or deficit visual fields. Training was performed at home for six months, consisting of repeated visual discriminations at a single location for 20-30 minutes per day. Pre- and post-training testing was identical, consisting of Humphrey Visual Fields, Macular Integrity Assessment Perimetry, Ocular Coherence Tomography, motion discrimination performance, and visual quality of life questionnaires. Primary outcome measures were changes in perimetric mean deviation (PMD) on Humphrey Visual Field Analyzer in both eyes. The results showed mean PMDs improved over 6 months in Deficit-trained subjects, and no improvement was observed in Sighted-trained subjects. However, there were no significant differences between alternative training modalities. It was concluded that while there is no widely accepted therapy available to treat homonymous hemianopia, this study evaluated the efficacy of visual perceptive training as a potential therapy.

In a 2019 Cochrane systematic review, Pollock et al. sought to determine the effects of various interventions for people with visual field defects following a stroke. Randomized trials in adults after a stroke were selected if the intervention was specifically targeted at improving the visual field or improving the ability of the participant to cope with vision loss. The primary outcome was functional ability in ADL and secondary outcomes included functional ability in other ADL, including reading ability, visual field measures, balance, falls, depression and anxiety, discharge destination or residence after stroke, quality of life and social isolation, visual scanning, AEs, and death. There were 20 studies that evaluated the effect of treatments for visual field defects, however only 10 of them compared the effect of a particular treatment with no treatment. Of these, four studies investigated a type of eye movement training designed to improve the lost visual field (a 'restitutive' intervention), four studies investigated the effect of scanning training, which involves training people to 'scan' across the space in front of them and into the 'lost' visual field, in order to better cope with their lost vision (a 'compensatory' intervention), and three studies investigated the effect of wearing a special prism on a pair of glasses,

which increases the amount a person can see on their affected side (a 'substitutive' intervention). One of the studies investigated the effect of specialized assessment by an orthoptist (a hospital-based vision specialist), compared to standard care. Only two studies presented data relating to how treatment can improve stroke survivors' abilities in ADLs, and there was a lack of consistency across studies that limited our ability to draw clear conclusions. There was insufficient evidence to draw any conclusions about the effectiveness of restitutive interventions as compared to control. There was low or very low-quality evidence that scanning training may help improve quality of life but may have no effect on other outcomes (including AEs). There was low or very-low quality evidence that prisms may have an effect on the ability to scan (look) for objects but may cause a range of minor AEs (particularly headache) and may have no effect on other outcomes. Limitations with the evidence meant that we could not draw any conclusions about the benefits of assessment interventions.

Hunt et al. (2016) conducted a systematic review of evidence regarding the use of oculomotor-based vision assessment to identify and monitor recovery from mild traumatic brain injury (mTBI). Their objectives were to (1) identify changes in oculomotor-based vision following mTBI; (2) distinguish methods of assessment; (3) appraise the level and quality of evidence; and, if warranted, (4) determine clinical recommendations for assessment. Articles were included if study populations were clearly identified as having mTBI and used as an assessment of oculomotor-based vision. Twenty articles met their inclusion criteria. Exploratory findings suggest that measurements of saccades, smooth pursuit, and vergence are useful in detecting changes associated with mTBI. The authors noted that the strength of this evidence is not yet sufficient to warrant clinical recommendations. Research using rigorous methods is required to develop reliable, valid, and clinically useful assessment protocols.

In a systematic review of interdisciplinary literature, Klinke et al. (2015) identified rehabilitation interventions that can be integrated into ward-based nursing for individuals with hemi-spatial neglect following stroke in the right brain hemisphere. Using 41 original studies, 11 interventions were identified. The selected studies were graded according to the strength of their evidence (Levels 1-5); the proposed interventions were given recommendation grades (Grades A-D). The interventions included right half-field eye patching (Grade D), smooth pursuit of eye-movement training (Grade B) and visual scanning training (Grade D). The authors noted that there was generally low level of evidence and the diversity of interventions which made it difficult to endorse specific priorities and combinations for implementation and interventions should be applied after careful evaluation of each individual's unique capacities and problems. The authors also emphasized the need to integrate evidence-based interventions to stimulate rehabilitation outcomes and further research.

Van Wyk et al. (2014) evaluated the effect of saccadic eye movement training with visual scanning exercises (VSEs) integrated with task-specific activities on USN post stroke. A matched-pair RCT was conducted. Subjects were matched according to their functional activity level and allocated to either a control (n = 12) or an EG (n = 12). All participants received task-specific activities for a 4-week intervention period. The EG received saccadic eye movement training with VSE integrated with task specific activities as an "add on" intervention. Assessments were conducted weekly over the intervention period. Statistically significant differences were noted on the King-Devick Test (p = .021), Star Cancellation Test (p = .016), and Barthel Index (p = .004). The authors concluded that intensive saccadic eye movement training with VSE integrated with task-specific activities has a significant effect on USN in individuals post stroke. Long-term follow-up and further studies with larger populations are needed to verify these results.

Orthoptic or Vision Therapy (VT) for Dyslexia and Other Learning Disabilities (LD)

Only limited quality clinical evidence was found to support the use of orthoptic or VT for dyslexia and other LDs. Findings are limited by single-arm design and inconclusive findings.

In 2018, Hussaindeen et al. carried out a study at a center for LD to report the frequency of BV anomalies in children with specific learning disorders (SLD) and to assess the efficacy of VT in children with non-strabismic BV anomaly (NSBVA). The study consisted of 94 children with a diagnosis of SLD. Children with BCVA of ≥ 6/9 - N6, who are cooperative for examination and free from any ocular pathology, were assessed for BV. Participants diagnosed with NSBVA (n = 46) 24 of 46 were randomized to VT, with no intervention for 22 participants placed in the experimental control. Each group received ten sessions of VT, with a BV assessment performed for both the intervention and non-intervention groups. The results showed BV anomalies in 59 children (62.8%); of the 59 children, 13 (22%) had strabismic binocular vision anomalies (SBVA) and 46 participants (78%) had NSBVA. Most seen in individuals with NSBVA was accommodative infacility (AIF), found in 67%, followed by CI in 25%. The intervention group showed significant improvement post-VT and met all the BV parameters (Wilcoxon signed rank test, $p < 0.05$) apart from negative fusional vergence.

Hall et al. (2013) conducted a randomized, double-blind trial with 73 delayed readers to compare changes in reading and spelling as well as irregular and non-word reading skills after 3 months of wearing either the Harris or the Dyslexia Research Trust (DRT) filters. Reading improved significantly after wearing either type of filter, with 40% of the children improving their reading age by 6 months or more during the 3-month trial. However, spelling ability and non-word reading

improved significantly more with the DRT than with the Harris filters. The authors concluded that education and rehabilitation professionals should consider colored filters as an effective intervention for delayed readers experiencing visual stress. According to the authors, this research will help to support the use of colored filters for visual reading capacity, but further rigorous research is needed. The study is limited by a lack of comparison group undergoing a non-filter intervention or no intervention.

In a double-masked, placebo crossover RCT, Ritchie et al. (2011) tested the efficacy of Irlen colored overlays for alleviating reading difficulties thought to have been caused by Irlen syndrome, a proposed perceptual disorder with controversial diagnostic status. Sixty-one school children (aged 7-12 years) with reading difficulties were included in the study. Based on the study results, the authors concluded that Irlen colored overlays do not have any demonstrable immediate effect on reading in children with reading difficulties.

Clinical Practice Guidelines

American Academy of Ophthalmology (AAO)

The AAO's 2021; updated 2023 Preferred Practice Pattern guidelines for pediatric ophthalmology/strabismus summary benchmarks for treating:
Amblyopia:

- All children with amblyopia should be offered treatment regardless of age, including older children and teenagers, especially if not treated previously.
- Prognosis for attaining normal vision depends upon age of onset, cause, severity, and duration of amblyopia, history of and response to previous treatment, adherence to treatment, and concomitant conditions.
- The first goal is to correct any cause of visual deprivation; the second goal is to correct refractive errors likely to cause blur; third is to promote use of the amblyopic eye, ultimately to achieve equal VA between the two eyes.
- Choose treatment based on age; VA; adherence and response to previous treatment; physical, social, and psychological status.
- Once maximal VA has been obtained, treatment intensity can be tapered to maintenance therapy.
- If VA in amblyopic eye is maintained as therapy is tapered, treatment may be stopped but with follow up planned because approximately one-fourth of children experience a recurrence within the first year off treatment.

The AAO's amblyopia preferred practice pattern (Repka et al. 2017) states that timely treatment of amblyopia usually improves VA and binocularity, and it decreases the likelihood of severe visual handicap if there is loss of vision in the fellow eye later in life. The prognosis for attaining normal vision in an amblyopic eye depends on many factors, including the age of onset; the cause, severity, and duration of amblyopia; the history of and response to previous treatment; adherence to treatment recommendations; and concomitant conditions. Several strategies are used in the treatment of amblyopia:

- Treatment of refractive error alone is the initial step in care of children 0 to 17 years of age with amblyopia (moderate quality, strong recommendation).
- Patching is an appropriate choice for treatment for children who do not improve with eyeglasses alone or who experience incomplete improvement (moderate quality, strong recommendation).
- Patching as initial therapy after refractive correction should be considered for children with moderate amblyopia (20/40 to 20/80) (moderate quality for treatment of amblyopia, strong recommendation) with a prescribed dose of 2 hours of daily patching or weekend atropine (moderate quality for amount of time treatment, discretionary recommendation).
- Patching should be considered for older children and teenagers, particularly if they have not previously been treated.(moderate quality, discretionary recommendation).
- Pharmacological treatment that produces cycloplegia of the non-amblyopic eye is an appropriate choice for treatment for children who do not improve with eyeglasses alone. (moderate quality, strong recommendation).
- There is insufficient evidence to recommend VT techniques.

American Association for Pediatric Ophthalmology and Strabismus (AAPOS)/ American Academy of Ophthalmology (AAO)

In 2022, the AAPOS and AAO created a joint statement on vision screening for infants and children. The recommendations for community and school screening programs state that in community and school-based screening programs, screeners should have specific training in vision screening techniques and protocols as recommended by the Academy and AAPOS. Children who do not pass these screenings should be referred to for an additional ocular assessment performed by the primary care provider or an eye care provider with training and experience in treating children.

In the primary care setting, the Academy and AAPOS recommend that an ocular assessment be performed whenever questions arise about the health of the visual system of a child of any age. In addition, even without specific signs or symptoms, they recommend that infants and children be routinely screened for vision problems and that any child who does not pass one or more of these screening tests have an ophthalmological examination.

- A pediatrician, family physician, or other appropriately trained health care provider should examine a newborn's eyes for general eye health and perform a red reflex test in the nursery. Any baby with an abnormal red reflex requires urgent consultation. An ophthalmologist should be asked to examine all high-risk infants (i.e., those at risk of developing retinopathy of prematurity (ROP); those with a family history of retinoblastoma, glaucoma, or cataracts in childhood; those with a family history of retinal dystrophy/degeneration; those with systemic diseases or neurodevelopmental delays associated with eye problems; those with any opacity of the ocular media; or those with nystagmus).
- From 1 month to 4 years of age, infants and toddlers should have their ocular health assessed at each routine well-child visit, including an external inspection, pupillary examination, corneal light reflection, and fixation, and following behavior assessment. This assessment should address any concerns raised by the family or noted by the primary care provider.
- Emphasis should be placed on checking VA when a child is cooperative enough to complete the assessment. Generally, this occurs between the ages of 3 ½ and four years. This assessment can be performed by a pediatrician, family practitioner, ophthalmologist, optometrist, orthoptist, nurse, or other appropriately trained individuals. Screeners should not have a vested interest in the screening outcome. A child referred from a vision screening or uncooperative at a second attempt at vision testing should be referred for a comprehensive eye evaluation. It is essential that formal testing of VA be performed by the age of 5 years.
- Photo screening and handheld autorefraction may be electively performed in children 12 months to 3 years of age, allowing earlier detection of conditions that may lead to amblyopia. Photo screening and handheld automated refraction are recommended as an alternative to VA screening with vision charts (typically used for children 3 through 5 years of age) and in children who are unable or unwilling to cooperate with routine acuity screening with vision charts (but are not superior to vision chart testing for children able to participate). Using vision charts to assess amblyopia in children 3 to 5 years of age remains a viable practice.
- Additional screening on each child should be done at routine school checks or well-child visits every 1-2 years after age five. Regular comprehensive professional eye examinations performed on normal asymptomatic children have no proven medical benefit.
- Children with possible or diagnosed learning disabilities, such as dyslexia, should undergo a comprehensive eye examination to identify and treat any undiagnosed vision impairment. Such children should be referred for appropriate medical, psychological, and educational evaluations and treatment of any learning disability. There is inadequate scientific evidence to suggest that "defective eye teaming" and "accommodative disorders" are common causes of educational impairment. Hence, routine screening for these conditions is not recommended.

Many serious ocular conditions are treatable if identified through screening during the preschool and early school-aged years. Many of these conditions are associated with a positive family history. Therefore, additional emphasis should be directed to screening high-risk infants and children, and when necessary, screeners should readily refer such children to an ophthalmologist for a comprehensive eye evaluation (2022).

In a joint policy statement, the AAPOS and the AAO state that amblyopia is a medical condition and requires treatment. Amblyopia is typically a preventable and treatable form of vision loss caused by developmental abnormalities of the brain’s vision centers. Unless amblyopia is treated promptly during childhood, permanent structural changes occur in the brain, resulting in decreased visual function; recovery of vision in this instance is rarely achieved.

Current methods of preschool vision screening can identify risk factors (primarily high levels of refractive error and anisometropia) that, if untreated, increase the likelihood of amblyopia developing. Therefore, these amblyopia risk factors should also be considered medical conditions.

Optical correction such as eyeglasses and contacts may be medically indicated as a part of amblyopia treatment in addition to other modalities, such as patching and/or pharmacologic treatment (AAPOS, AAO; 2002, revised and reaffirmed 2017).

American Optometric Association (AOA)

In their guideline on care of the patient with accommodative and vergence dysfunction, the AOA states that improvement in both accommodative and vergence adaptation systems is the basis of the success of VT. According to the guideline, data is lacking for the efficacy of home-based VT by itself. Home-based VT may be less effective than office-based therapy, as there is no therapist available to provide motivation or correct inappropriate procedures. Therefore, preferred

clinical management involves office-based VT in combination with home therapy. They note that therapy combining diplopia awareness with operant-conditioning techniques to reinforce alignment in the absence of visual cues has been advocated for divergence excess, and that VT is usually successful in patients with divergence insufficiency (Cooper et al., 2010).

The AOA (2009) issued a clinical care publication on the definition of optometric VT. The document states that research has demonstrated VT can be an effective treatment option for:

- Ocular motility dysfunctions (eye movement disorders).
- Non-strabismic binocular disorders (inefficient eye teaming).
- Strabismus (misalignment of the eyes).
- Amblyopia (poorly developed vision).
- Accommodative disorders (focusing problems).
- Visual information processing disorders, including visual-motor integration and integration with other sensory modalities.
- Visual sequelae of acquired brain injury.

The AOA clinical practice guideline on care of the patient with learning related vision problems describes these as deficits in two broads' visual system components: visual efficiency and visual information processing.

- Visual efficiency comprises the basic visual physiological processes of VA (and refractive error), accommodation, vergence, and ocular motility.
- Visual information processing involves higher brain functions including the non-motor aspects of visual perception and cognition, and their integration with motor, auditory, language, and attention systems. Learning related vision problems are the manifestation of deficits in visual efficiency and visual information processing.
- Visual efficiency problems include uncorrected refractive error, dysfunction of accommodation and vergence control systems and the interaction of these systems, and ocular motility. Accommodative and vergence dysfunctions can be primary deficits or can occur secondary to uncorrected refractive error. Isolated visual efficiency deficits are relatively uncommon; most patients presented with multiple deficits.

This guideline also notes that correction of refractive error and treatment of visual efficiency dysfunctions can result in improved visual information processing. The treatment of vision information processing deficits usually requires VT, which can begin during the later stages of visual efficiency therapy. This is dependent on associated conditions such as accommodative and vergence dysfunction (Garzia et al., 2008).

In their clinical guideline on the care of the patient with amblyopia, the AOA states that the rationale for using occlusion is that occluding the better eye stimulates the amblyopic eye, decreasing inhibition by the better eye. Occlusion enables the amblyopic eye to enhance neural input to the visual cortex. It is also important in eliminating eccentric fixation. However, noncompliance with occlusion represents a significant factor in occlusion failures, especially in patients over eight years of age in whom up to 50 percent noncompliance is common. They also note that active VT for amblyopia is designed to remediate deficiencies in four specific areas: eye movements and fixation, spatial perception, accommodative efficiency, and binocular function. The goal of VT is remediation of these deficiencies, with subsequent equalization of monocular skills and, finally, integration of the amblyopic eye into binocular functioning. Untreated individuals with amblyopia are at a greater risk for loss of vision in the better eye (Rouse et al., 1994; revised 2004).

National Institute for Health and Care Excellence (NICE)

In the 2023 NICE guidelines on stroke rehabilitation in adults the recommendations on vision are as follows:

- Offer people who are in hospital after stroke a specialist orthoptist assessment as soon as possible. If this cannot be done before discharge, offer the person an urgent outpatient appointment.
- Offer eye movement therapy to people who have persisting hemianopia (blindness in one half of the visual field of one or both eyes) after stroke.

Department of Veterans Affairs and the Department of Defense (VA/DoD)

In 2022, the Department of Veterans Affairs and the Department of Defense Clinical Practice Guideline for the Management and Rehabilitation of Post-acute Mild TBI states that "There is insufficient evidence to suggest for or against the use of any particular modality for the treatment of visual symptoms attributed to mild traumatic brain injury such as diplopia, accommodation or convergence deficits, visual tracking deficits and/or photophobia" (Eapen et al., 2022).

U.S. Food and Drug Administration (FDA)

This section is to be used for informational purposes only. FDA approval alone is not a basis for coverage.

Vision therapy is a procedure and, as such, is not subject to FDA regulation. Devices used in vision training programs may be classified under several different product codes. Some of these devices may be exempt from the 510(k)-clearance process. For information on a specific device or manufacturer refer to the following website: http://www.accessdata.fda.gov/scripts/cdrh/cfdocs/cfPMN/pmn.cfm. (Accessed May 23, 2025)

NovaSight announced that the FDA has cleared CureSight, a digital therapy device for amblyopia (lazy eye). CureSight is an eye-tracking-based system that improves visual and stereo acuity by training the visual system to use both eyes simultaneously. The ground-breaking clearance was based on visual outcomes data from a multicenter, RCT in which 103 participants aged 4 to < 9 were randomized to CureSight or eye patching—the current gold standard-of-care treatment. Decision date 2022 Sep 29. For more information, refer to the following website: https://www.accessdata.fda.gov/cdrh_docs/pdf22/K221375.pdf. (Accessed May 23, 2025)

NovaVision™, an attention task performance recorder, consists of two software programs, one for healthcare professionals for precise diagnosing of visual deficiencies, develop specific therapies and analyze results of therapy. The other software is intended for individuals in their homes to train and improve impaired visual functions. It is intended for the diagnosis and improvement of visual functions for those with impaired vision that may result from trauma, stroke, inflammation, surgical removal of brain tumors or brain surgery, and may also be used to improve visual function for those with amblyopia. Additional information is available at: http://www.accessdata.fda.gov/cdrh_docs/pdf2/K023623.pdf. (Accessed May 23, 2025)

Luminopia One, Luminopia Inc. was granted De Novo classification (DEN210005) on February 26, 2021. According to the FDA website, Luminopia is a software-only digital therapeutic designed to be used with commercially available Head-Mounted Displays (HMDs), which are compatible with the software application. Luminopia One is indicated for improvement in VA for individuals with amblyopia, aged 4-7, associated with anisometropia and/or mild strabismus, having received treatment instructions (frequency and duration) as prescribed by a trained eye-care professional. Luminopia One is intended for both previously treated and untreated people. Luminopia One is intended to be used as an adjunct to full-time refractive correction, such as glasses, which should also be worn under the HMD during Luminopia One therapy. Luminopia One is intended for prescription use only in an at-home environment. Additional information is available at: https://www.accessdata.fda.gov/cdrh_docs/pdf21/DEN210005.pdf. (Accessed May 23, 2025)

The RevitalVision technology 510K: K012530 was originally FDA cleared in 2001 (originally branded as the NeuroVision AA-1 system) for treating amblyopia in patients aged ≥ 9 years. Additional information is available at: https://www.accessdata.fda.gov/cdrh_docs/pdf/K012530.pdf. (Accessed May 23, 2025)

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Policy History/Revision Information

Date	Summary of Changes

03/01/2026	**Coverage Rationale**
	• Revised list of proven and medically necessary indications; removed:
	  ○ Occlusion therapy or pharmacologic penalization therapy for treating Amblyopia
	  ○ Prism adaptation therapy for treating Esotropia
	• Revised list of unproven and not medically necessary indications; removed:
	  ○ Virtual perception therapy for treating any type of learning disability or language disorder
	  ○ Vision restoration therapy for treating visual field deficits following stroke or neurotrauma
	  ○ Visual information processing evaluation to diagnose reading or other learning disabilities
	Definitions
	• Removed definition of:
	  ○ Occlusion Therapy
	  ○ Pharmacologic Penalization Therapy
	  ○ Prism Adaptation Therapy
	  ○ Vision Restoration Therapy (VRT)
	Applicable Codes
	• Removed CPT code 92499
	Supporting Information
	• Updated *Description of Services*, *Clinical Evidence*, and *References* sections to reflect the most current information
	• Archived previous policy version CS131OH.B

Instructions for Use

This Medical Policy provides assistance in interpreting UnitedHealthcare standard benefit plans. When deciding coverage, the federal, state (Ohio Administrative Code [OAC]) or contractual requirements for benefit plan coverage must be referenced as the terms of the federal, state (OAC) or contractual requirements for benefit plan coverage may differ from the standard benefit plan. In the event of a conflict, the federal, state (OAC) or contractual requirements for benefit plan coverage govern. Before using this policy, please check the federal, state (OAC) or contractual requirements for benefit plan coverage. UnitedHealthcare reserves the right to modify its Policies and Guidelines as necessary. This Medical Policy is provided for informational purposes. It does not constitute medical advice.

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