

Visual Information Processing Evaluation and Orthoptic and Vision Therapy

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[➔ Instructions for Use](#)

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Related Community Plan Policy
<ul style="list-style-type: none"> Cognitive Rehabilitation
Commercial Policy
<ul style="list-style-type: none"> Visual Information Processing Evaluation and Orthoptic and Vision Therapy

Application

This Medical Policy does not apply to the states listed below; refer to the state-specific policy/guideline, if noted:

State	Policy/Guideline
Indiana	None
Kentucky	Visual Information Processing Evaluation and Orthoptic and Vision Therapy (for Kentucky Only)
Louisiana	Visual Information Processing Evaluation and Orthoptic and Vision Therapy (for Louisiana Only)
Mississippi	None
New Jersey	None
Pennsylvania	None
Tennessee	Visual Information Processing Evaluation and Orthoptic and Vision Therapy (for Tennessee Only)

Coverage Rationale

Some plans specifically exclude benefits for vision therapy (orthoptic training). Check benefit plan descriptions for allowable number of visits where benefit is available.

The following are proven and medically necessary:

- [Occlusion Therapy](#) or [Pharmacologic Penalization Therapy](#) for treating [Amblyopia](#)
- [Orthoptic Therapy](#) or [Vision Therapy](#) for treating [Convergence Insufficiency](#)
- [Prism Adaptation Therapy](#) for treating [Esotropia](#)

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
- Virtual perception therapy for treating any type of learning disability or language disorder

- [Vision Restoration Therapy \(VRT\)](#) for treating visual field deficits following stroke or neurotrauma
- Visual information processing evaluation to diagnose reading or other learning disabilities
- Remote, online and/or digital therapy for Amblyopia

Definitions

Amblyopia: Amblyopia is 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 the 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 of the 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).

Occlusion Therapy: Patching or occlusion therapy is the mainstay of amblyopia treatment. Patching the unaffected, or good eye provides monocular stimulation to the amblyopic eye, promoting visual development. Occlusion therapy is prescribed to improve vision, and as a rule, does not eliminate strabismus (AAPOS, 2021).

Orthoptic Therapy: 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)

Pharmacologic Penalization Therapy: The instillation of pharmacologic drops (e.g., atropine) to penalize the better seeing eye by forcing the brain to pay attention to the image coming from the weaker eye, prompting the brain to learn to see better from the weaker eye (AAPOS, 2021).

Prism Adaptation Therapy: The use of clear, triangular shaped objects that bend light to permit alignment of the visual axes, simulating the absence of Strabismus. It is also proposed as a way to more accurately determine the angle of deviation or the target angle for Strabismus surgery (AAO, 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 Restoration Therapy (VRT): An in-home computer-based program designed to strengthen the visual information processing of residual neuronal structures that have survived following acute lesions of the nervous system resulting from trauma, stroke, inflammation, or elective surgery for removal of brain tumors. By repeated activation through the course of the therapy, patients use the program to train and improve their impaired visual functions, and thus regain useful vision in the area of the visual field deficit. (NovaVision, 2021).

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
92499	Unlisted ophthalmological service or procedure

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Diagnosis Code	Description
H51.11	Convergence insufficiency
H51.12	Convergence excess

Description of Services

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

Vision Therapy is also referred to as 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 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 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.

Conventional Therapies for Amblyopia

Li et al. (2020) conducted a systematic review and network meta-analysis (NMA) of 23 studies (n = 3,279) to establish a comparative efficacy between refractive correction, patching, atropine, atropine weekly plus Plano lens, optical penalization, and binocular therapy for treatment of amblyopia. Only randomized control trials comparing two or three of the following treatments were included in the NMA: refractive correction, patching for two-hours a day, six hours a day, 12 hours a day and two-hours a day plus doing near activities, patching for two hours plus doing distant activities, atropine daily, atropine weekly, atropine weekly plus a Plano lens over the sound eye, optical penalization, and binocular therapy. Optical penalization was the least effective of all the treatments for the change of visual acuity, refractive lenses (mean difference [MD], 2.9 Log MAR lines; 95% credibility interval [CrI], 1.8–4.0), patch two-hours (MD, 3.3; 95% CrI, 2.3–4.3), patching six hours (MD, 3.6; 95% CrI, 2.6–4.6), patch 12 hours (MD, 3.4; 95% CrI, 2.3–4.5), patching two hours plus near activities (MD, 3.7; 95% CrI, 2.5–5.0), patching two hours plus doing distant activities (MD, 3.5; 95% CrI, 2.1–5.0), atropine daily (MD, 3.2; 95% CrI, 2.2–4.3), atropine weekly (MD, 3.2; 95% CrI, 2.2–4.3), atropine weekly plus a Plano lens (MD, 3.7; 95% CrI, 2.7–4.7), binocular therapy (MD, 3.1; 95% CrI, 2.0–4.2). Patching six hours and patching two hours plus doing near activities were better than refractive correction ([MD, 0.73; 95% CrI, 0.10–1.40]; [MD, 0.84; 95% CrI, 0.19–1.50]). The authors concluded the clinical efficacy among various amblyopia treatments were comparable but did not determine any significant differences. Further high-quality randomized control studies are needed to determine efficacy between refractive correction, patching, atropine, atropine weekly plus Plano lens, optical penalization, and binocular therapy for treatments. The following publications, discussed in more detail below, were reviewed as part of this systematic review: (Manh et al., 2018, Herbison et al., 2016, Wallace et al., 2013).

In a meta-analysis of part-time (PTO) versus full-time occlusion therapy (FTO) for treatment of amblyopia, Yazdani et al. (2017) included six studies (three RCTs and three non-RCTs). Pooled standardized difference in the mean changes in the visual acuity (VA) was 0.337 (lower and upper limits: 0.009, 0.683) higher in the FTO as compared to the PTO group; however, this difference was not statistically significant ($p = 0.056$, Cochrane Q value = 20.4 ($p = 0.001$), $I^2 = 75.49\%$). Egger's regression intercept was 5.46 ($p = 0.04$). The pooled standardized difference in means of VA changes was 1.097 [lower and upper limits: 0.68, 1.513] higher in the FTO arm ($p < 0.001$), and 0.7 [lower and upper limits: 0.315, 1.085] higher in the PTO arm ($p < 0.001$) compared to PTO less than two hours. The authors concluded that this meta-analysis showed no statistically significant difference between PTO and FTO in treatment of amblyopia. However, their results suggest that the minimum effective PTO duration, to observe maximal improvement in VA is six hours per day.

In a Cochrane Database Systematic Review, Taylor and Elliott (2014) evaluated the most effective treatment for strabismic amblyopia in particular, to examine the impact of conventional occlusion therapy and analyze the role of partial occlusion and optical penalization for the condition. Three RCTs for the treatment of strabismic amblyopia for participants of any age were selected. No RCTs were found that assessed the role of either partial occlusion or optical penalization to refractive correction for strabismic amblyopia. The review found that occlusion, while wearing necessary refractive correction, appears to be more effective than refractive correction alone in the treatment of strabismic amblyopia.

Repka et al. (2014) published a follow up study of a randomized trial using atropine vs. patching for treatment of moderate amblyopia. The VA of patients at 15 years of age who were younger than 7 years when enrolled in a treatment trial for moderate amblyopia was reported in the original multicenter clinical trial, 419 children with amblyopia (VA, 20/40 to 20/100) were randomly assigned to patching (minimum of 6 h/d) or pharmacologic penalization with atropine sulfate eyedrops, 1% (1 drop daily), for 6 months. Treatment after 6 months was at the discretion of the investigator. Two years after enrollment, an unselected subgroup of 188 children were enrolled into long-term follow-up. At 15 years of age, most children treated for moderate amblyopia when younger than 7 years have good VA, although mild residual amblyopia is common. The authors found the outcome to be similar regardless of initial treatment with atropine or patching. Better VA at the 15-year examination was achieved in those who were younger than 5 years at the time of entry into the RCT (mean logMAR, 0.09) compared with those aged 5 to 6 years (mean logMAR, 0.18; $p < .001$). When the authors compared subgroups based on original treatment with atropine or patching, no significant differences were observed in VA of amblyopic and fellow eyes at 15 years of age ($p = .44$ and $p = .43$, respectively). The authors concluded that the results indicate that improvement occurring with amblyopia treatment is maintained until at least 15 years of age.

In a prospective, multicenter RCT, the Pediatric Eye Disease Investigator Group (PEDIG) evaluated the effectiveness of increasing prescribed daily patching from 2 to 6 hours in children with stable residual amblyopia. The study group consisted of

169 children aged 3 to < 8 years (mean, 5.9 years) with stable residual amblyopia (20/32–20/160) who had received 2 hours of daily patching for at least 12 weeks. The main outcome measure was BCVA in the amblyopic eye after 10 weeks. Ten weeks after randomization, amblyopic eye VA had improved an average of 1.2 lines in the 6-hour group and 0.5 line in the 2-hour group (difference in mean VA adjusted for acuity at randomization = 0.6 line; 95% confidence interval, 0.3–1.0; $p = 0.002$). Improvement of 2 or more lines occurred in 40% of participants patched for 6 hours versus 18% of those who continued to patch for 2 hours ($p = 0.003$). The authors concluded that when amblyopic eye VA stops improving with 2 hours of daily patching, increasing the daily patching dosage to 6 hours results in more improvement in VA after 10 weeks compared with continuing 2 hours daily (Wallace et al., 2013).

In an RCT, Rutstein et al. (2010a) evaluated whether VA improvement with Bangerter filters is similar to improvement with patching as initial therapy for children with moderate amblyopia. The study enrolled 186 children, 3 to < 10 years old, with moderate amblyopia. Children were randomly assigned to receive either daily patching or to use a Bangerter filter on the spectacle lens in front of the fellow eye. Study visits were scheduled at 6, 12, 18, and 24 weeks. At 24 weeks, amblyopic eye improvement averaged 1.9 lines in the Bangerter group and 2.3 lines in the patching group. The authors concluded that because the average difference in VA improvement between Bangerter filters and patching was less than half a line and there was lower burden of treatment on the child and family, Bangerter filter treatment is a reasonable option to consider for initial treatment of moderate amblyopia. The authors indicated that although the mean difference between groups was only 0.38 line, the end of the confidence interval on the difference was 0.76 line, and thus, treatment with Bangerter filters did not quite meet the prespecified definition of non-inferiority to patching when initiating therapy for moderate amblyopia. However, the authors also did not find that patching was statistically superior to Bangerter filters. Therefore, the authors could not conclude that the Bangerter filter treatment effect is similar to that seen with patching (based on our predefined definition of non-inferiority).

In a prospective, RCT, Agervi et al. (2010) compared spectacles plus patching 8 hours or more daily 6 days a week with spectacles plus patching 8 hours or more on alternate days to treat amblyopia in 40 children 4 to 5 years of age. The main outcome measure was median change in BCVA of the amblyopic eye after 1 year. The median change in BCVA of the amblyopic eye did not differ significantly between the two groups. Binocular function improved in both groups with no significant differences between the groups at 1 year. The investigators concluded that the magnitude of change in the BCVA 1 year after spectacles plus prescribed alternate-day patching was not significantly different than that after spectacles plus prescribed daily patching to treat amblyopia in children 4 to 5 years old. The effect of patching was not separate from that of optical correction with a period of refractive adaptation. Thus, the improvement in VA is a combined effect of spectacle wear and occlusion therapy.

A 2009 multicenter RCT by PEDIG compared weekend atropine sulfate use augmented by a Plano lens for the sound eye (optical penalization/study group) with weekend atropine use alone (pharmacologic penalization/control group) for moderate amblyopia in 180 children aged 3 years to younger than 7 years. Primary outcome measured was masked assessment of amblyopic eye VA using the Amblyopia Treatment Study HOTV testing protocol at 18 weeks. The researchers concluded that optical penalization was not substantially better than pharmacologic penalization in this patient population.

Elhousseiny et al. (2021) conducted 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 anisometric and/or strabismic amblyopia with amblyopia treatment failure. Eleven participants underwent eight weeks of binocular treatment using virtually reality headset that contained a therapeutic software application. The sham-crossover group ($n = 9$) underwent four week 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 virtual reality headset that delivered the visual input to each eye dichoptically. Outcomes in the full-treatment group ($n = 11$), the mean amblyopic eye logMAR visual acuity 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 adverse events (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 visual acuity. Stereoacuity did improve compared to baseline measurements when all participants were combined. The current 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.

Birch et al. (2020) conducted a randomized control trial 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 two hours per day, seven days a week. The outcomes measured were changes in the amblyopic eye best-corrected visual acuity at the two-week visit. Baseline factors examined were age at enrollment, visual acuity, stereoacuity, and suppression. At baseline the mean amblyopic eye best-corrected visual acuity \pm SD was 0.49 \pm 0.16 logMAR (\sim 20/63 \pm 1.6 lines), range = 0.3–0.8 logMAR (20/40–20/125). Visual acuity 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%, CI95% = 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%, CI95% = 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%, CI95% = 28%–65%) did not improve, and one child (4%, CI95% = 1%–20%) decreased by –0.1 logMAR]. At the 2-week visit, 35% (95%CI: 19% - 55%) of children playing the binocular game had recovered normal visual acuity for age (\leq 0.2 logMAR; 20/32 or better). Only 8% (CI95% = 2% - 26%) of the children in the patching group had recovered normal visual acuity for age at the 2-week visit. The authors concluded that after two weeks of treatment, visual acuity improvement was significantly greater with the binocular game treatment than patching. Children with moderate amblyopia and orthotropia had more visual acuity 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 the parents.

In 2019, Rajavi et al. conducted a randomized control trial 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 a 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 a day and to play I-BiT™ games with no red-green glasses, 20 to 30 minutes per a 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™ game for six hours total during one month in both groups. Compliance in 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 best corrected visual acuity (BCVA). Additionally, some participants were excluded after randomization due to lack of compliance, which could introduce biases in the findings.

Manh et al. (2018) conducted a randomized controlled trial (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 measure was change in amblyopic eye VA from baseline to 16 weeks. Mean amblyopic eye VA improved from baseline by 3.5 letters (2-sided 95% confidence interval [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 patient 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.

In 2016 Herbison et al. (2016) conducted a three-arm randomized control trial was performed on children (n = 75) 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 DVD (n = 24). The I-BiT game being used is a virtual reality technology that uses either DVD footage or computer games that present a common background 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 visual acuity between the group treated with I-BiT game versus non-I-BiT game which I measured by using a logMAR visual acuity 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 there was modest visual acuity 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. 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 visual acuity 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.

Prism Adaptation Therapy for Esotropia

In a 2019 retrospective case control study, Choe et al. aimed to investigate the long-term outcome of prism glasses after full hypermetropic correction for partially accommodative esotropia (PAET). 124 children aged 10 or younger with a residual esotropia of ≤ 20 prism diopters (PD) after full hypermetropic correction who were fitted with prism glasses and followed for 3 or more years were included. Clinical characteristics and the angle of esodeviation were obtained at each follow-up examination. Successful motor outcome after 3 years of prismatic correction was determined if the residual angle of esotropia after full hypermetropic correction was ≤ 10 PD. Patients who eventually weaned off prism glasses were noted. The results showed 30.6% success with 7.3% weaned off prism glasses after three years of prism-wear. Smaller amount of latent esodeviation ($p = 0.001$) revealed by prism adaptation and good fusional response at near with the Worth 4-dot test were significant prognostic factors of success by multivariate analysis ($p = 0.033$). After 3 years of wearing prism glasses, the rate of improvement in stereoacuity was higher in the Success group (60.5% vs. 27.9%) ($p = 0.001$), however, there was no significant difference between the prism-weaned group and prism-wearing group within the Success group ($p > 0.05$). The authors concluded that prism glasses for small angle PAET can be a treatment option for patients who have a small angle of latent esodeviation revealed by prism adaptation and good sensory function at near, but early surgery may be better as the majority of patients showed suboptimal outcomes even after long-term wearing of prism glasses.

In a retrospective review, Quigley et al. (2017) evaluated the prism adaptation therapy (PAT) response and postoperative outcomes in a cohort of children with accommodative esotropia who underwent bilateral medial rectus recession. The authors reported that 36% of patients showed a requirement for increase of prism dosage to maintain orthotropia during PAT; these patients did better than those whose deviation was stable, with postoperative rate of motor success (defined as $\leq 10\Delta$ esotropia) of 100% versus 56%. PAT may be a useful positive prognostic test, and it also identifies a substantial patient population who may avoid under correction, the prism builders. The authors suggest that additional randomized studies are required to demonstrate definitive benefit of PAT.

The National Eye Institute sponsored the Prism Adaptation Study (PAS), a multicenter RCT to determine the overall effect of prism adaptation (PA). The study randomized 333 eligible patients who were at least 3 years of age, had no previous eye surgery, and had acquired deviations of 12 to 40 prism diopters. All patients had 20/40 or better VA in each eye, and amblyopic patients underwent occlusion therapy before entry. Two levels of randomization were used. Sixty percent of the patients ($n = 199$) underwent PA and 40% ($n = 134$) did not. Those who did not have PA underwent conventional surgery for their entry angle of deviation. Of those who responded to prisms with motor stability and sensory fusion ($n = 131$), half ($n = 67$) underwent a conventional amount of surgery, i.e., surgery for angle at entry, and half ($n = 64$) underwent augmented surgery based on the prism-adapted angle of deviation. A successful outcome was defined as a deviation of less than or equal to 8 prism diopters of esotropia or exotropia. Success rates 6 months after surgery were highest in PA responders who underwent augmented surgery and lowest in patients who did not undergo PA (89% versus 72%). The estimated overall rate of success for patients who went through the PA process was significantly better than the success rate of patients who did not undergo PA but underwent surgery for their deviation at entry into the study (83% versus 72%). The investigators concluded that there was a beneficial overall effect of the PA process for patients with acquired esotropia (PAS Research Group, 1990).

Therapies for Convergence Insufficiency (CI)

Alvarez et al. (2020) conducted a double-masked, randomized control trial to study the neuro mechanism of convergence insufficiency 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. 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 (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, positive fusional vergence and self-reported symptoms through a Convergence Insufficiency Symptom Survey (CISS) score. The mean near point of convergence improved by 6.0 and 3.1 cm in both the office-based vergence/accommodative and office-based placebo therapy groups. With a mean difference of -2.9 cm; 95% confidence interval [CI], -4.6 to -1.0 cm; $p < .01$. The mean positive fusional vergence increased by 17.3 and 7.4 Δ in both the office based vergence/accommodative and office-based placebo therapy groups. With a mean difference of 9.9 Δ ; 95% CI, 4.9 to 16.0 Δ ; $p < .001$. The mean CISS score improved by 12.4 and 10.1 points in both the office-based vergence/accommodative and office-based placebo therapy groups. With a mean difference 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 office-based placebo therapy for improving clinical outcomes of near point of convergence and positive fusional vergence 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 randomized control trials that included both children and adults ($n = 1,289$) with symptomatic convergence insufficiency. The study measured the effectiveness of non-surgical interventions for convergence insufficiency. The outcomes measured required both clinical measures of convergence to be normal, and also 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% confidence interval (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.

A randomized controlled trial (CITT-ART Investigator Group, 2019) was designed to determine whether treating symptomatic convergence insufficiency would lead to better reading fluency and comprehension. Three hundred eleven children aged 9 to 14 years with symptomatic convergence insufficiency were randomly assigned to 16 weeks of office-based vergence/accommodative therapy or to placebo therapy. Improvements in (1) near point of convergence (NPC), (2) positive fusional vergence (PFV), and (3) self-reported symptoms (Convergence Insufficiency Symptom Survey [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 convergence insufficiency. 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.

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

In an RCT, Scheiman et al. (2011) assessed the effectiveness of various types of vision therapy for improving accommodative amplitude or accommodative facility in 221 children with deficiencies in these measures at baseline. All types of vision therapy (i.e., office-based vision therapy, HBCVAT+, and HBPP) were superior to office-based placebo vision treatment for improving

mean accommodative amplitude. With regard to accommodative facility, only the office-based vision therapy group exhibited a significantly greater improvement than the placebo group. This study did not report the results of symptoms or other clinical signs. One year after completion of therapy, reoccurrence of decreased accommodative amplitude was present in only 12.5% and accommodative facility in only 11%. The authors concluded that vision therapy/orthoptics is effective in improving accommodative amplitude and accommodative facility in school-aged children with symptomatic CI and accommodative dysfunction.

Shin et al. (2011) conducted a prospective controlled trial comparing office-based vision therapy with no vision therapy treatment. The study included 57 children aged 9-13 years who were diagnosed with symptomatic CI (n = 27) or combined symptomatic convergence insufficiency (CI) and accommodation insufficiency (AI) (n = 30). They were independently divided into a treatment and a control group, matched by age and gender. Office-based vision therapy significantly improved symptoms and clinical signs including near point of convergence (NPC), positive fusional vergence, mean accommodative amplitude, and mean accommodative facility relative to no treatment in children with CI and AI. Of the patients with concurrent CI and AI who received vision therapy, 77% were considered improved and 61% were considered cured. Of the 11 patients who completed the 1-year follow-up, symptom scores had deteriorated to abnormal levels in two children and one child also showed regression of the NPC. The authors concluded that this study supports the use of vision therapy as a successful method of treating CI and CI combined with AI.

The National Eye Institute sponsored the Convergence Insufficiency Treatment Trial (CITT) study, a RCT comparing the effectiveness of different treatment options for the condition in 221 children (age 9 to 17 years). Three types of vision therapy were compared with a placebo therapy intervention. Vision therapy included: (1) office-based vision therapy 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 vision therapy with at-home reinforcement achieved normal vision or had significantly fewer symptoms of CI. In comparison, only 43% of patients who completed home-based therapy alone showed similar results, as did 33% of patients who used HBCVAT+ and 35% of patients who underwent office-based placebo therapy (Convergence Insufficiency Treatment Trial Study Group, 2008).

Vision Therapy 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 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 for Exotropia

Only limited quality clinical evidence was found to support the use of orthoptic or vision therapy for exotropia.

Feng et al. (2021) conducted a randomized control trial in (n = 60) participants with intermittent exotropia (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: SE anisometropia ≥ 1.00 D; astigmatism ≥ 1.00 D in either eye; or SE hyperopia $\geq + 1.00$ D. Group two (n = 30) was treatment group and they were prescribed over minus lenses of -2.50 D combined with the two PD base-in prism on each side. Any participant who did not need refractive correction were prescribed Plano lens to be worn at each follow-up visit, but not to be worn in the during the trial. Ocular alignment, status of binocular vision 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 strabismus in children with IXT. Limitations of the study 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 therapy on long-term surgical success in early-onset exotropia in 51 consecutive patients. 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 patients (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 patients who were deemed as compliant (≥ 50%) than in the group of patients who were deemed to be non-compliant (< 50%). 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 surgery with other interventions, including botulinum toxin A therapy, orthoptic exercises, occlusion, binocular vision training and watchful waiting. The evidence retrieved was of limited extent and quality with differences across studies in terms of outcome assessment and most appropriate time-point for measuring long-term outcomes. There were mixed outcomes when comparing unilateral recession/resection (R&R) with bilateral lateral rectus recession (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 intermittent exotropia (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).

In a 2013 Cochrane systematic review, Hatt and Gnanaraj analyzed the effects of various surgical and non-surgical treatments in randomized trials of people with intermittent exotropia, to report intervention criteria and determine the significance of factors such as age with respect to outcome. The authors searched for RCTs of any surgical or non-surgical treatment. One randomized trial was eligible for inclusion in the review. This trial showed that unilateral surgery was more effective than bilateral surgery for correcting basic intermittent exotropia. According to the authors, measures of severity and criteria for intervention were poorly validated for all identified studies. The authors concluded that there is a need for improved measures of severity, a better understanding of the natural history and carefully planned clinical trials to improve the evidence base for the management of this condition.

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. Data collected included angle, near stereoacuity, VA, control of distance exotropia measured with the Newcastle Control Score (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) 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 for Stroke and Traumatic Brain Injury

Only limited quality clinical evidence was found to support the use of orthoptic or vision therapy for stroke and traumatic brain injury.

Qui et al. (2021) performed a meta-analysis of seven randomized control trials including (n = 211) participants reviewing the efficacy of prism adaptation (PA) treatment in unilateral neglect post-stroke. Of the seven studies included, one study investigated the effects of prism adaptation in acute post-stroke neglect and another study examined the chronic stage of stroke rehabilitation. Four studies reviewed terminal prism adaptation, two studies reviewed concurrent prism adaptation, 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 prism adaptation 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 prism adaptation did not have significant short-term or long-term beneficial effects which showed significant improvement in neglect symptoms of unilateral stroke patients. 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 prism adaptation, parameter of visual shift, and follow-up duration. The authors concluded the application of prism adaptation, 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 prism adaptation therapy for unilateral post-stroke participants.

Cavanaugh et al. (2020) published the results of a randomized clinical trial 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. 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 the 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 the vision loss. The primary outcome was functional ability in activities of daily living and secondary outcomes included functional ability in other activities of daily living, 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, adverse events, 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 activities of daily living, 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 adverse events). There was low or very-low quality evidence that prisms may have an effect on ability to scan (look) for objects but may cause a range of minor adverse events (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 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 patients 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 eye-movement training (Grade B) and visual scanning training (Grade D). The authors noted that there was general 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 patient'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 unilateral spatial neglect (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 experimental group (n = 12). All patients received task-specific activities for a 4-week intervention period. The experimental group 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 patients post stroke. Long-term follow-up and further studies with larger patient populations are needed to verify these results.

A National Institute for Health and Care Excellence (NICE) guidance document states that eye movement therapy can be offered to people who have persisting hemianopia after stroke and who are aware of the condition. This recommendation was based on 3 RCTs, the confidence level of results ranging from very low to moderate (2013).

Orthoptic or Vision Therapy for Dyslexia and Other Learning Disabilities

Only limited quality clinical evidence was found to support the use of orthoptic or vision therapy for dyslexia and other learning disabilities.

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 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.

Visual Information Processing Evaluation

Limited clinical evidence was found to support the use of visual information processing evaluations for diagnosing learning-related or other types of visual deficits.

Hopkins et al. (2019) conducted a study to evaluate the association between performance on visual information processing tests and academic performance in 222 second grade school children, with a mean age of 8-8.5 years. The Progressive Achievement Tests in Reading (PAT-R) and Mathematics (PAT-M) were used as assessment tools. Both tests are timed, paper

based, standardized tests, referenced against the Australian national curriculum used in schools across Australia to monitor student progress, typically across testing sessions 9– 12 months apart. The results showed that visual information processing assessed using the Visual- Motor Integration (VMI) and Developmental Eye Movement (DEM) measures were significantly associated with academic performance. However, given that the VMI task involves visual spatial, visual analysis and visual motor skills, it may be more relevant than the DEM test in capturing the diverse range of activities (e.g., reading, writing and mathematics) carried out by children in a classroom. In a clinical setting, a child's academic performance can play an important role in the optometric management of conditions such as hyperopia, thus tests, such as the VMI, can provide clinicians with insight into a child's potential overall academic performance and support clinicians regarding their management decisions. Limitations of this study include the potential for normal developmental differences in children of the same age or year in school, as well as the authors did not include assessment of refractive error, accommodation, or general IQ tests. It is important that future research include these parameters to assess if the provision of optometric interventions can improve academic performance in longitudinal studies.

Goldstand et al. (2005) compared visual and visual-information processing skills between children with and without mild reading and academic problems and examine the incidence of visual deficits among them. A total of 71 seventh graders classified as proficient (n = 46) and non-proficient (n = 25) readers were compared with respect to scores on an accepted vision screening, on tests of visual-perception, visual-motor integration, and academic performance. Further, academic performance and visual-information processing were compared between children who failed and passed the vision screening. Visual deficits were found in 68% of the participants, and among significantly more boys than girls. Non-proficient readers had significantly poorer academic performance and vision-screening scores than the proficient readers. Participants who passed the visual screening performed significantly better in visual perception than those who failed. According to the investigators, visual function significantly distinguishes between children with and without mild academic problems, as well as on visual-perception scores. The investigators concluded that the high occurrence of visual deficits among participants warrants consideration of vision deficits among school children with academic performance difficulties. These findings require confirmation in a larger study.

Visual Perceptual Therapy

Only limited quality clinical evidence was found to support the use visual perceptual therapy.

In a prospective study, Yalcin and Balci (2014) evaluated the efficacy of neural vision therapy, also known as perceptual vision therapy, in enhancing best corrected visual acuity (BCVA) and contrast sensitivity function in amblyopic patients. The study enrolled 99 subjects (age 9 to 50 years) previously diagnosed with unilateral hypermetropic amblyopia. The subjects were divided into two groups, with 53 subjects (53 eyes) in the perceptual vision therapy group and 46 subjects (46 eyes) in the control group. Study phases included a baseline screening, a series of 45 training sessions with perceptual vision therapy, and an end-of-treatment examination. BCVA and contrast sensitivity function at 1.5, 3, 6, 12, and 18 cycles per degree spatial frequencies were obtained for statistical analysis in both groups. All subjects had follow-up examinations within 4-8 months. With the exception of one subject from the study group and two subjects from the control group, all subjects had occlusion during childhood. The study was not masked. The results for the study group demonstrated a mean improvement of 2.6 logarithm of the minimum angle of resolution (logMAR) lines in VA (from 0.42 to 0.16 logMAR). Contrast sensitivity function improved at 1.5, 3, 6, 12, and 18 cycles per degree spatial frequencies. The control group did not show any significant change in VA or contrast sensitivity function. None of the treated eyes showed a drop in VA. The authors concluded that the results of the study demonstrate the efficacy of perceptual vision therapy in improving VA. According to the authors, long-term follow-up and further studies are needed to verify these results.

Vision Restoration Therapy (VRT)

Only limited quality clinical evidence was found to support the use of vision restoration therapy.

In a prospective, double-blind, placebo-controlled RCT, Sabel and Gudlin (2014) determined if behavioral activation of areas of residual vision using daily 1-hour VRT for glaucoma for 3 months improved detection accuracy compared with placebo. The study participants included a volunteer sample of patients with glaucoma (mean age, 61.7 years) with stable visual fields and well-controlled intraocular pressure. Study interventions included computer based VRT for glaucoma (n = 15) or visual discrimination placebo training in the intact visual field (n = 15). After randomization, 4 patients withdrew from the trial because of mild headaches (n = 2) or lack of time to complete the schedule (n = 2). The primary end point was change in detection accuracy in high-resolution perimetry. VRT for glaucoma led to significant detection accuracy gains in high-resolution perimetry,

which were not found with white-on-white or blue-on-yellow perimetry. Furthermore, the pre-post differences after VRT for glaucoma were greater compared with placebo in all perimetry tests, and these results were independent of eye movements. VRT for glaucoma (but not placebo) also led to faster reaction time. Vision-related quality of life (QOL) was unaffected, but the health-related quality-of-life mental health domain increased in both groups. The authors concluded that visual field defects caused by glaucoma can be improved by repetitively activating residual vision through training the visual field borders and areas of residual vision, thereby increasing their detection sensitivity. According to the authors, this trial revealed evidence that visual field loss is in part reversible by behavioral, computer-based, online controlled vision training, comprising a new rehabilitation treatment option in glaucoma. These findings require confirmation in a larger study with long-term follow-up.

Jung et al. (2008) evaluated the effects of VRT on the visual function of 10 patients with anterior ischemic optic neuropathy in a double-blind pilot RCT. All patients were evaluated before VRT and after 3 and 6 months of treatment by Early Treatment Diabetic Retinopathy Study (ETDRS) VA, contrast sensitivity, reading speed, 24-2 SITA-standard Humphrey visual field (HVF), High Resolution Perimetry (HRP) (perimetry obtained during VRT), and vision-based QOL questionnaire. Patients were randomized between two VRT strategies (5 in each group): I) VRT in which stimulation was performed in the seeing VF of the affected eye (“seeing field-VRT”); II) VRT in which stimulation was performed along the area of central fixation and in the ARV (areas of residual vision) of the affected eye (“ARV-VRT”). The results of the HRP, HVF, and clinical assessment of visual function were compared for each patient and between the two groups at each evaluation. VA qualitatively improved in the ARV-VRT group; however, the change was not statistically significant. Binocular reading speed significantly improved in the ARV-VRT group. HVF foveal sensitivity increased mildly in both groups. HRP analysis showed a similar increase in stimulus accuracy in both groups (mean improvement of about 15%). All patients reported functional improvement after VRT. A small study population limits the conclusions that can be reached from this study.

Mueller et al. (2007) performed a case series including observational analysis of visual fields of 302 patients before and after being treated with computer-based VRT for a period of 6 months. The visual field defects were due to ischemia, hemorrhage, head trauma, tumor removal or anterior ischemic optic neuropathy. Primary outcome measure was a visual field assessment with super-threshold perimetry. VRT improved patients’ ability to detect super-threshold stimuli in the previously deficient area of the visual field by 17.2% and these detection gains were not significantly correlated with eye movements. Notable improvements were seen in 70.9% of the patients. Efficacy was independent of lesion age and etiology, but patients with larger areas of residual vision at baseline and patients older than 65 years benefited most. Conventional perimetry validated visual field enlargements and patient testimonials confirmed the improvement in every day visual functions. The lack of a control group limits the validity of the results of this study.

Clinical Practice Guidelines

American Academy of Pediatrics (AAP)/Section on Ophthalmology, Council on Children with Disabilities/American Academy of Ophthalmology (AAO)/American Association for Pediatric Ophthalmology and Strabismus (AAPOS)/American Association of Certified Orthoptists (AACO)

According to a joint policy statement issued by the AAP, AAO, AAPOS, and AACO, diagnostic and treatment approaches for dyslexia that lack scientific evidence of efficacy such as behavioral vision therapy, eye muscle exercises, or colored filters and lenses are not endorsed or recommended. The ophthalmologist should identify and treat any significant visual defect according to standard principles of treatment. Strabismus, amblyopia, and refractive errors may require glasses, eye patching, eye drops, or eye-muscle surgery. In addition, the ophthalmologist should discuss the lack of efficacy of vision therapy and other “alternative treatments” with the parents (AAP, 2009; reaffirmed 2014).

A 2011 joint technical report by the same societies indicates that vision problems can interfere with the process of reading, but children with dyslexia or related learning disabilities have the same visual function and ocular health as children without such conditions. Learning disabilities constitute a diverse group of disorders in which children who generally possess at least average intelligence have problems processing information or generating output. Their etiologies are multifactorial and reflect genetic influences and dysfunction of brain systems. Currently, there is inadequate scientific evidence to support the view that subtle eye or visual problems cause or increase the severity of learning disabilities. According to the report, scientific evidence does not support the claims that visual training, muscle exercises, ocular pursuit-and-tracking exercises, behavioral/perceptual vision therapy, “training” glasses, prisms, and colored lenses and filters are effective direct or indirect treatments for learning disabilities. There is no valid evidence that children who participate in vision therapy are more responsive to educational instruction than children who do not participate (Handler and Fierson, 2011).

American Academy of Ophthalmology (AAO)

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).
- There is insufficient evidence to recommend vision therapy techniques.

Additional strategies for treatment of amblyopia, such as pharmacologic therapy, are also addressed in this preferred practice pattern.

In a separate policy statement, the AAO (2013) maintains that children with possible or diagnosed learning disabilities, such as dyslexia, should undergo a comprehensive eye examination so that any undiagnosed vision impairment can be identified and treated. Such children should be referred for appropriate medical, psychological, and educational evaluations and treatment of any learning disability. The organization states that there is insufficient evidence to conclude that "defective eye teaming" and "accommodative disorders" can be underlying causes of educational impairment.

The AAO esotropia and exotropia preferred practice pattern (Wallace et al., 2018) states the potential benefits of treatment for esotropia include promoting binocular vision and normal visual function in each eye. If binocularity is achieved, the number of surgical procedures over a lifetime may be reduced. Treatment should be considered for all forms of esotropia, and binocular alignment should be established as soon as possible, especially in young children, to maximize binocular potential to prevent or facilitate treatment of amblyopia and to restore normal appearance.

The following are included in the list of current treatment practices for esotropia:

- Correction of refractive errors
- Bifocal eyeglasses
- Prism therapy
- Amblyopia treatment

The AAO includes the following in its list of current treatment practices for exotropia:

- Correction of refractive errors
- Stimulating accommodative convergence (overcorrection of myopia or under-correction of hyperopia)
- Patching (anti-suppression) therapy
- Amblyopia treatment
- Prism therapy
- Convergence exercises for convergence insufficiency exotropia

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

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)

The AOA (2009) issued a clinical care publication on the definition of optometric vision therapy. The document states that research has demonstrated vision therapy 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

According to the AOA's revised guideline on the care of the patient with strabismus: esotropia and exotropia, vision therapy is successful in the treatment of many forms of strabismus. The AOA states that vision therapy or orthoptics involves active training procedures to improve the patient's fixation ability and oculomotor control, to help eliminate amblyopia, to improve sensory and motor fusion, and to increase facility and the range of accommodation and vergence responses. They note that the prognosis is most favorable for patients with intermittent strabismus, especially intermittent exotropia, who have sensorimotor fusion at some point in space and those with recently developed strabismus (Rutstein et al., 2010b).

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 vision therapy. According to the guideline, data is lacking for the efficacy of home-based vision therapy by itself. Home-based vision therapy 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 vision therapy in combination with home therapy. They note that therapy combining diplopia awareness with operant-conditioning technique to reinforce alignment in the absence of visual cues has been advocated for divergence excess, and that vision therapy is usually successful in patients with divergence insufficiency (Cooper et al., 2010).

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 8 years of age in whom up to 50 percent noncompliance is common. They also note that active vision therapy 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 vision therapy is remediation of these deficiencies, with subsequent equalization of monocular skills and, finally, integration of the amblyopic eye into binocular functioning. Untreated amblyopic patients are at a greater risk for loss of vision in the better eye (Rouse et al., revised 2004).

The AOA clinical practice guideline on care of the patient with learning related vision problems describes these as deficits in two broad 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 present 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 vision therapy, 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).

United States Preventative Services Task Force (USPSTF)

The USPSTF (2017) recommends the primary treatment for amblyopia as the correction of any underlying refractive error with the use of corrective lenses, occlusion therapy (eye patching, atropine eye drops, or Bangerter occlusion foils), or a combination of treatments.

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 a number of 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/pmnm.cfm>. (Accessed September 10, 2021)

NovaVision™, an attention task performance recorder, consists of two software programs, one for healthcare professionals for precise diagnosing of visual deficiencies, develop patient specific therapies and analyze results of therapy. The other software is intended for patients in their homes to train and improve impaired visual functions. It is intended for the diagnosis and improvement of visual functions in patients 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 in patients with amblyopia. Additional information is available at: http://www.accessdata.fda.gov/cdrh_docs/pdf2/K023623.pdf. (Accessed September 10, 2021)

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Policy History/Revision Information

Date	Summary of Changes
06/01/2022	<p>Application <i>Nebraska and North Carolina</i></p> <ul style="list-style-type: none">Updated language to indicate this Medical Policy applies to the states of Nebraska and North Carolina (retired state-specific policy versions) <p>Supporting Information</p> <ul style="list-style-type: none">Archived previous policy version CS131.K

Instructions for Use

This Medical Policy provides assistance in interpreting UnitedHealthcare standard benefit plans. When deciding coverage, the federal, state or contractual requirements for benefit plan coverage must be referenced as the terms of the federal, state or contractual requirements for benefit plan coverage may differ from the standard benefit plan. In the event of a conflict, the federal, state or contractual requirements for benefit plan coverage govern. Before using this policy, please check the federal, state 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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