Article • Digital Therapies for Amblyopia

Man Kin (Eric) Chow • Miami, Florida

Man Kin (Eric) Chow
Miami, Florida

Owner, Miami Vision Therapy

Fellow, American Academy of Optometry (FAAO)

Fellow, Optometric Vision Development & Rehabilitation Association (FOVDR)

Clinical Affiliate Faculty/Preceptor, Nova Southeastern University College of Optometry

Children's Vision Committee, Florida Optometric Association

ABSTRACT

Amblyopia is a developmental visual disorder with consequences beyond reduced visual acuity, affecting stereoacuity, contrast sensitivity, oculomotor function, and eye-hand coordination. While patching remains the longstanding standard of care, adherence challenges and its inherently monocular approach have driven the development of a new generation of digital and perceptual learning-based therapies. This article reviews five clinically relevant technologies—Luminopia, CureSight, Eye Hero, Bynocs, and RevitalVision—examining their mechanisms of action, treatment protocols, and supporting clinical evidence. Collectively, these platforms represent a meaningful expansion of the amblyopia treatment toolbox, offering patients and clinicians options that are engaging, home-based, and in many cases, capable of addressing the binocular and cortical deficits that patching alone does not target. Selecting the right tool requires an understanding of each platform's unique delivery, its evidence base, and the patient's individual visual profile.

Keywords: amblyopia, dichoptic therapy, perceptual learning, digital therapeutics

Introduction

Amblyopia is a developmental visual disorder resulting from atypical binocular experience in early childhood, leading to abnormal visual cortex development and vision impairment. Recovery relies on neuroplasticity in the visual cortex.[1] While reduced visual acuity is the hallmark most clinicians recognize, amblyopia's impact extends far beyond the size of a letter on the eye chart. Affected individuals demonstrate deficits in contrast sensitivity, stereoacuity, spatial localization, spatial resolution, oculomotor function (including pursuits, saccades, and fixation stability), accommodation, vergence, suppression patterns, eye-hand coordination, motion perception, and temporal processing.[2,3]

For decades, the primary evidence-based treatment has been patching. The landmark PEDIG Amblyopia Treatment Studies, published over twenty years ago in 2003, established the foundational dosing parameters still used today: ATS 2A demonstrated that 6 hours per day of patching was equally effective as full-time patching for severe amblyopia, and ATS 2B showed that 2 hours per day was equally effective as 6 hours for mild to moderate amblyopia. These findings were groundbreaking at the time and remain clinically relevant, but they also define the lower bound of what we ask of our patients: a minimum of 2 hours per day with a patch over a child's eye. Anyone who has treated amblyopia with patching knows the main obstacle isn't the prescription, it is compliance. Adherence to patching has been reported to be between 40 and 60% by week 6 and may fall to approximately 30% by week 12.[4] A treatment that children resist wearing, that carries social stigma, and that doesn't quite address the binocular nature of the condition leaves room for improvement.

The good news is that the gap is being filled. A new generation of digital and perceptual learning-based therapies is reshaping how we approach amblyopia treatment. In this article, I will review five clinically relevant emerging technologies—Luminopia, CureSight, Eye Hero, Bynocs, and RevitalVision—examining the science behind each, the evidence supporting their use, and what they mean for the future of amblyopia care.

Luminopia

Luminopia is a prescription digital therapeutic for amblyopia, the first FDA-cleared device of its kind. It received FDA clearance in 2021, with a commercial launch in 2023, and is indicated for children ages 4–12 with amblyopia secondary to anisometropia or mild strabismus (under 5 prism diopters).

The core mechanism is dichoptic therapy: presenting different images to the right and left eye simultaneously to reduce the brain's suppression of the amblyopic eye and to encourage both eyes to work together. What makes Luminopia unique in its delivery is that, rather than games or abstract exercises, children watch their own selected TV shows and movies through a virtual reality headset. The software modifies streaming content in real time, applying a global contrast reduction to the fellow eye so that the brain must rely on the amblyopic eye's input to perceive the full image. The result is a treatment that feels less like therapy and more like screen time.

The standard prescribed dose is one hour per day, six days per week. Parents have access to a monitoring portal that lets them track their child's daily usage and select content from an approved library, providing families with both oversight and a degree of personalization.

Xiao et al.[5] conducted the pivotal Phase 3 randomized controlled trial, enrolling 105 children ages 4–7 with unilateral amblyopia from anisometropia, strabismus, or both, with amblyopic eye visual acuity between 20/40 and 20/200. Children were randomized 1:1 to Luminopia plus glasses versus glasses alone for 12 weeks. The Luminopia group improved by 1.8 lines in visual acuity compared to 0.8 lines in the glasses-only group, a statistically significant difference of 1.0 line. Notably, 62% of Luminopia-treated children achieved two or more lines of improvement, compared to 33% in the control group (glasses only), and median adherence reached 88%. These results were compelling enough that the trial was stopped early for success and formed the basis for FDA clearance.

CureSight

CureSight is a prescription, FDA-cleared, home-based dichoptic treatment for amblyopia that combines real-time eye tracking technology, red-blue anaglyph glasses, and streamed video content. It is indicated for children ages 4 to under 9 with anisometropic, small-angle strabismic (up to 5 prism diopters) or mixed-mechanism amblyopia, with amblyopic eye visual acuity between 20/32 and 20/100.[6,7]

As with Luminopia, children watch their own selected TV shows and movies, but the technology behind CureSight is distinctly different. Rather than applying a global contrast reduction to the fellow eye, CureSight uses a built-in eye tracker on an 11.6-inch computer monitor to continuously track each eye's gaze in real time. Using this gaze data, the software applies a targeted, dynamic blur specifically around the fovea of the stronger fellow eye—only where that eye is actually looking, moment by moment—while leaving the amblyopic eye's view completely sharp and unaffected. The blur diameter and intensity are automatically calibrated to each child's measured visual acuity: the worse the amblyopia, the larger and stronger the blur applied to the fellow eye. The prescribed dose is 90 minutes per day, five days per week for 16 weeks, totaling 120 hours of treatment.

The pivotal evidence comes from a prospective, multicenter, randomized, evaluator-masked, controlled noninferiority trial across six sites in Israel that led directly to FDA clearance.[8] Children (n=103) were randomized 1:1 to CureSight versus standard patching for 16 weeks. CureSight achieved a mean VA improvement of 2.8 lines, compared with 2.3 lines in the patching group, with 79% of CureSight-treated children achieving 2 or more lines of improvement, versus 61% in the patching group. CureSight also demonstrated significant improvement in stereoacuity and binocular VA, an important distinction, as Luminopia's pivotal RCT did not show a significant stereoacuity benefit. It is worth noting, however, that the patching group in this study showed an essentially identical stereoacuity improvement of 0.40 log arcseconds. Adherence was 91% for CureSight versus 83% for patching.

Wygnanski-Jaffe et al.[8] followed the original RCT patients for one year after treatment stopped, with no additional amblyopia treatment permitted. VA gains were fully maintained at 12 weeks post-treatment with no regression. At one year, children lost less than one line from their end-of-treatment peak but retained approximately two full lines of improvement compared to baseline, a residual gain that remained statistically significant ($p<0.0001$). Stereoacuity and binocular VA gains were similarly maintained, and amblyopia recurrence occurred in only 5 of 27 patients at the one-year mark.

Eye Hero

Eye Hero is a gamified, app-based dichoptic vision therapy platform, developed by Hundred Vision and designed for home use in children with amblyopia and mild strabismus. It is downloaded as an app and used on a tablet or computer screen. Children wear red-green anaglyph glasses to separate the images presented to each eye. The amblyopic eye receives high-contrast stimuli, while the fellow eye receives attenuated input through the red filter, and interactive games are played during therapy. Eye Hero is commercially available but is not FDA-cleared.

The platform operates on dichoptic principles, presenting complementary stimuli to each eye under conditions that require binocular cooperation to reduce interocular suppression and to promote functional binocularity. A proprietary adaptive algorithm continuously adjusts game content and difficulty in real time based on the child's accuracy, reaction time, and consistency. Importantly, Eye Hero is designed to target not only visual acuity but a broader range of visual functions, including oculomotor control, selective attention, and hand-eye coordination. This reflects the understanding that amblyopia is a multisystem neurodevelopmental disorder. The prescribed dose is 30 minutes per day, five days per week, for six months.

The clinical evidence comes from a prospective non-randomized controlled study that had 29 children ages 7–13 with anisometropic amblyopia were enrolled: 14 in the treatment group and 15 age- and sex-matched typically developing controls who received no intervention.[3] What distinguished this study from most amblyopia trials was its multimodal assessment approach. They measured not only visual acuity and stereopsis but also oculomotor function via videonystagmography, motor proficiency via the BOT-2, and postural stability via the Sensory Organization Test.

Visual acuity in the amblyopic eye improved progressively across all four time points, with a total gain of approximately 1.5 lines at six months. Stereoacuity improved from a median of 300 arcseconds at baseline to 45 arcseconds at six months. That is a three-octave gain in binocular depth perception. Oculomotor improvements were equally compelling: saccadic latency decreased from 235 ms to 213 ms, smooth pursuit gain improved across all tested frequencies, and optokinetic gain improved from 0.65 to 0.73 in the amblyopic eye. Perhaps most strikingly, BOT-2 upper extremity coordination scores improved by nearly 40%, from 22.55 to 31.00 ($p<0.001$), and balance scores improved significantly as well. Controls showed no significant changes in any measured domain.

Bynocs

Bynocs is a cloud-based dichoptic vision therapy platform designed to treat amblyopia through gamified, computer-based training. It runs in a standard internet browser on any screen larger than 11 inches and requires only an internet connection and a pair of red-blue anaglyph glasses. Bynocs has been studied in children as young as 4 years old and in adults up to 30 years old, across multiple amblyopia types, including anisometropic, isometropic bilateral, strabismic, and deprivational amblyopia.

The platform uses red-blue anaglyph glasses to separate the images presented to each eye. What distinguishes Bynocs is its figure-ground stimulus design: the key game elements requiring active attention are visible only to the amblyopic eye, while the fellow eye sees the broader game environment. Color contrast between the two eyes is automatically adjusted so that the weaker eye perceives higher-contrast stimuli, and the stimuli presented to the amblyopic eye undergo continuous dynamic adjustments in size, spatial frequency, temporal frequency, and target speed as the patient improves. A notable feature is built-in remote supervision. Patients are monitored by a Bynocs optometrist via video call, with visual performance and compliance assessed after every ten sessions. The prescribed dose is 30 minutes per day, five days per week for six weeks.

There was a retrospective study from Mumbai analyzing data from 161 children ages 4–13, including both anisometropic (127 children) and isometropic bilateral amblyopia (34 children), a population typically excluded from other dichoptic studies.[6] With no control group, BCVA in the amblyopic eye improved by a mean of 0.39 logMAR, approximately four lines. The percentage of patients without measurable stereopsis dropped from 65.8% to 11.8%, and the percentage without flat fusion on Worth 4-dot fell from 61.5% to 6.3%. One limitation worth noting is that stereopsis was measured using the "Bynocs Randot Test," the platform's built-in tool, which raises a potential conflict of interest when assessing the platform's outcomes.

A study published in the Journal of Pediatric Ophthalmology and Strabismus by Ganesh,[7]

conducted at Aravind Eye Hospital in Coimbatore, evaluated 59 patients ages 5–30 across a broader range of amblyopia types. Of 74 eyes treated, 82.4% showed improved visual acuity, and 98.6% improved in at least one measured parameter. Stereopsis was assessed using independent validated tests, the TNO test for near and polarized random dot stereograms for distance, and the results were compelling: patients without measurable near stereopsis dropped from 47.5% to 11.9%, and 48% achieved normal near stereoacuity of 60 arcseconds or better. Among the 36 patients with residual amblyopia after failed patching, Bynocs produced a two-line improvement in VA (0.40 to 0.20 logMAR), compared to only a half-line improvement that those same patients had achieved with patching. Improvement was statistically significant both in patients ten years and under and in those older than ten, with no significant difference between age groups (p=0.123), directly challenging the assumption that amblyopia treatment is ineffective beyond the critical period. Durability data at a mean of 5.5 months post-treatment showed that most patients maintained their gains, with regression occurring in only 4 eyes (12.1%), primarily in strabismic cases.

RevitalVision

RevitalVision is an FDA-cleared perceptual learning software program developed by Talshir Medical Technologies in Israel, indicated for adults with amblyopia. It is software-only. No special glasses, headset, or hardware beyond a standard computer monitor is required. Beyond amblyopia, it has been reported to improve vision in several other conditions, including presbyopia, low myopia, post-cataract surgery, and post-LASIK surgery.[9]

Unlike the dichoptic platforms described above, RevitalVision is a monocular perceptual learning program that works by directly retraining the visual cortex.[10] In amblyopia, abnormal development of the primary visual cortex leads to disrupted lateral interactions among orientation-selective neurons, characterized by reduced facilitation and an abnormally extended range of inhibition.[10] RevitalVision addresses this by training the visual cortex using Gabor patches, which are gray-level sinusoidal gratings mathematically designed to match the receptive field structure of neurons in the primary visual cortex, eliciting a unique neural response in the exact cells that are dysfunctional in amblyopia.

During each session, the patient sits 1.5 meters from their computer screen in a dark room wearing their optical correction, with the fellow eye blurred using a semi-transparent cover. They are shown two brief sequential displays and must identify which display contains a target Gabor patch flanked by collinear high-contrast flankers, in a two-alternative forced-choice contrast-detection task. This configuration forces the brain to engage its lateral cortical interactions to detect the target. The program progressively increases the challenge across sessions in terms of contrast, spatial frequency, and orientation, systematically reducing pathological lateral inhibition and restoring facilitatory neural connections. The prescribed protocol is 30-minute sessions three to four times per week, for a total of 40 to 60 sessions over approximately four months.

The foundational evidence comes from a prospective, randomized, masked, placebo-controlled trial.[10] Seventy-seven amblyopic patients ages 9–55 were enrolled: 63 in the treatment group and 14 in a placebo control group that practiced a superficially similar task without the active flanker stimulation. There were 16 normal-vision controls. Both anisometropic and strabismic amblyopia were included, with strabismic subjects limited to less than 8 prism diopters of deviation. The treatment group achieved a 78% average improvement in visual acuity, approximately 2.5 lines, after a mean of 45 sessions, while the control group showed no improvement whatsoever. Of treated patients, 68% achieved two or more ETDRS lines of improvement, and 83% of patients who started with visual acuity worse than 20/40 ended treatment with visual acuity better than 20/40. Contrast sensitivity improved by a factor of 2 to 4 times across all spatial frequencies. Critically, improvement was not significantly dependent on age. Adults responded as well as older children, and gains were fully retained at 12-month follow-up, with additional improvement at higher spatial frequencies.

Discussion

The amblyopia treatment landscape has expanded well beyond the patch. The five technologies reviewed here—Luminopia, CureSight, Eye Hero, Bynocs, and RevitalVision—each bring a distinct mechanism, evidence base, and patient experience to the table, and none is universally superior to the others. Choosing the right tool requires knowing your patient's exam findings, interest, and needs.

Delivery format matters. A child who is motivated by gaming may thrive with Eye Hero or Bynocs, while one who simply wants to watch their favorite show may be better suited for Luminopia or CureSight. A patient whose amblyopia persists into adulthood may gravitate toward RevitalVision's cortical retraining approach. Whether treatment is delivered through a virtual reality headset or in free space with anaglyph glasses may also influence your patient's binocularity, comfort, acceptance, and ultimately adherence. Your choice depends on your knowledge of each tool, its limitations, and, above all, your patient's individual needs—because the right tool for one patient may not be the right one for the next.

The clinical profile of each patient should also guide selection. A child struggling specifically with stereoacuity may benefit from a treatment with demonstrated outcomes in stereopsis. One with documented oculomotor deficits or poor hand-eye coordination may be best served by a platform that targets those functions directly. Understanding the age ranges studied in each clinical trial helps us match the evidence to the patient sitting in our chair.

Conclusion

As clinicians, our role is no longer simply to prescribe a patch and monitor acuity. We are now equipped to be thoughtful about which technology best addresses each patient's specific visual profile, preferences, and goals. The more fluent we become in these tools, including their mechanisms, their evidence, and their limitations, the better positioned we are to individualize care. Amblyopia treatment has entered a new era, and our patients are better off for it.

References

1. Thompson B, Morrone MC, Bex P, Lozama A, Sabel BA. Harnessing brain plasticity to improve binocular vision in amblyopia: An evidence-based update. Eur J Ophthalmol 2024;34(4):901-12.
2. Magdalene D, Dutta P, Deshmukh S, Borah CJ, Nath RP. Neural vision perceptual learning as an effective treatment of amblyopia. Vision Dev Rehabil 2022;8(4):260-9.
3. Basoglu Y, Serbetcioglu MB, Cicek FD. AmblyoPlay-based multimodal visual therapy in pediatric anisometropic amblyopia: A pilot study of visual, oculomotor and sensorimotor outcomes. BMC Ophthalmol 2025;25:648. doi:10.1186/s12886-025-04481-2.
4. Wygnanski-Jaffe T, Moshkovitz A, Kushner BJ, Belkin M, Yehezkel O; CureSight Pivotal Trial Group. Binocular home treatment for amblyopia: Gains stable for one year. Am J Ophthalmol 2024;262:199-205.
5. Xiao S, Angjeli E, Wu HC, Gaier ED, et al. Luminopia Pivotal Trial Group. Randomized controlled trial of a dichoptic digital therapeutic for amblyopia. Ophthalmol 2022;129(1):77-85.
6. Abdal MO, Bhombal F, Nankani GJ, Nankani SG, et al. Evaluation of the efficacy of a new dichoptic digital platform to treat the anisometropic and isometropic amblyopia. Brain Sci 2022;12(7):815. doi:10.3390/brainsci12070815.
7. Ganesh S, Lusobya RC, Balasubramanian J, Jogitha, et al. Effectiveness of dichoptic therapy for treating mild to moderate amblyopia in a tertiary eye care center in South India. J Pediatr Ophthalmol Strabismus 2024;61(6):416-424. doi:10.3928/01913913-20240521-03.
8. Wygnanski-Jaffe T, Kushner BJ, Moshkovitz A, Belkin M, Yehezkel O; CureSight Pivotal Trial Group. An eye-tracking-based dichoptic home treatment for amblyopia: A multicenter randomized clinical trial. Ophthalmol 2023;130(3):274-85.
9. Hecht I, Yahalom C, Abaev O, Einan-Lifshitz A, et al. Efficacy of perceptual learning among patients with infantile nystagmus: A prospective single-blind randomised controlled trial. Br J Ophthalmol 2025. doi:10.1136/bjo-2025-328227.
10. Polat U, Ma-Naim T, Belkin M, Sagi D. Improving vision in adult amblyopia by perceptual learning. Proc Natl Acad Sci 2004;101(17):6692-7.

Correspondence regarding this article should be emailed to Man Kin (Eric) Chow at drchow@miamivt.com.

Chow MK. Digital therapies for amblyopia. Optom Vis Perf 2026;14(2):154-8.