

Digital Displays and Eye Fatigue; Can Screens Change Your Eye?

Introduction

The rapid rise in screen time in both children and adults has coincided with a marked global increase in myopia (nearsightedness). While genetic and environmental factors both contribute to myopia, a growing body of research points to **near-work activities** (like close distance or extended screen use) as critical risk factors. One of the key culprits? **Retinal defocus**, especially in the peripheral retina, induced by the flat, fixed-depth nature of conventional displays [1-3].

At [Brelyon](#), we're not just building immersive display systems—we're reimagining visual ergonomics. This article explores how one's visual environment shapes eye growth, and how **depth-based immersive displays** may support healthier visual behavior by altering key factors like accommodation and peripheral defocus.

The Problem with Near Work and Conventional Displays

Myopic defocus occurs when light rays converge and focus *in front* of the retina, while **hyperopic defocus** refers to light focusing *behind* the retinal surface, often in the peripheral regions (see Fig. 1). During near tasks—such as reading, using a computer, or viewing a smartphone—our eyes must converge and accommodate to maintain focus on close objects. Prolonged engagement in such activities places significant strain on the visual system. Although central accommodation may remain accurate, it does not fully correct for peripheral blur. This mismatch often results in **peripheral hyperopic defocus**, a condition illustrated in Fig. 1, where the peripheral image is focused behind the retina [4].

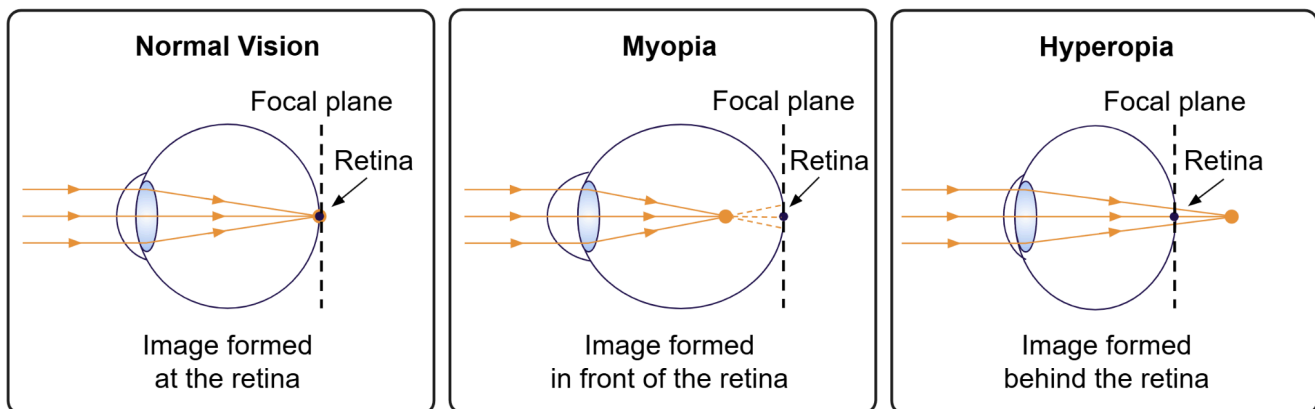


Figure 1: Schematic illustration of the definitions of the myopic and hyperopic defocus.

Numerous studies show that this type of defocus acts as a **biological signal for axial elongation** of the eyeball, the hallmark of progressive myopia [1-7]. In essence, when peripheral blur is interpreted as hyperopic, the eye “responds” by growing longer to bring the image into focus—ironically pushing central vision into myopic territory. The visual environment indoors compounds this problem: objects are close and unevenly distributed in depth, causing a complex “dioptric landscape” (the scene as the eye perceives it) across the retina [1]. In contrast, outdoor environments present **much more uniform optical fields**, allowing the eye to maintain consistent focus and reducing stimuli for axial elongation [8].

This is shown in Fig. 2 in which the comparison of different visual tasks and fixation distances reveals that indoor environments—due to their compact, three-dimensional structure—produce complex patterns of retinal defocus, especially in the peripheral retina [1]. Fig. 2 visually reinforces the concept that the eye's growth is regulated by the pattern of defocus across the retina, with peripheral hyperopic defocus promoting elongation and myopic defocus providing a “stop” signal [1]. When the peripheral retina experiences hyperopic defocus (as occurs with near work or small-screen use), there is a stimulus for axial elongation, leading to myopia progression. This demonstrates that this elongation is not uniform but is driven by localized optical signals, particularly in the peripheral retina, which can override central (foveal) focus cues. Conversely, when the peripheral retina is exposed to myopic defocus, axial elongation is inhibited or slowed, supporting the use of optical interventions (such as multifocal lenses) that induce peripheral myopic defocus to control myopia progression [7].

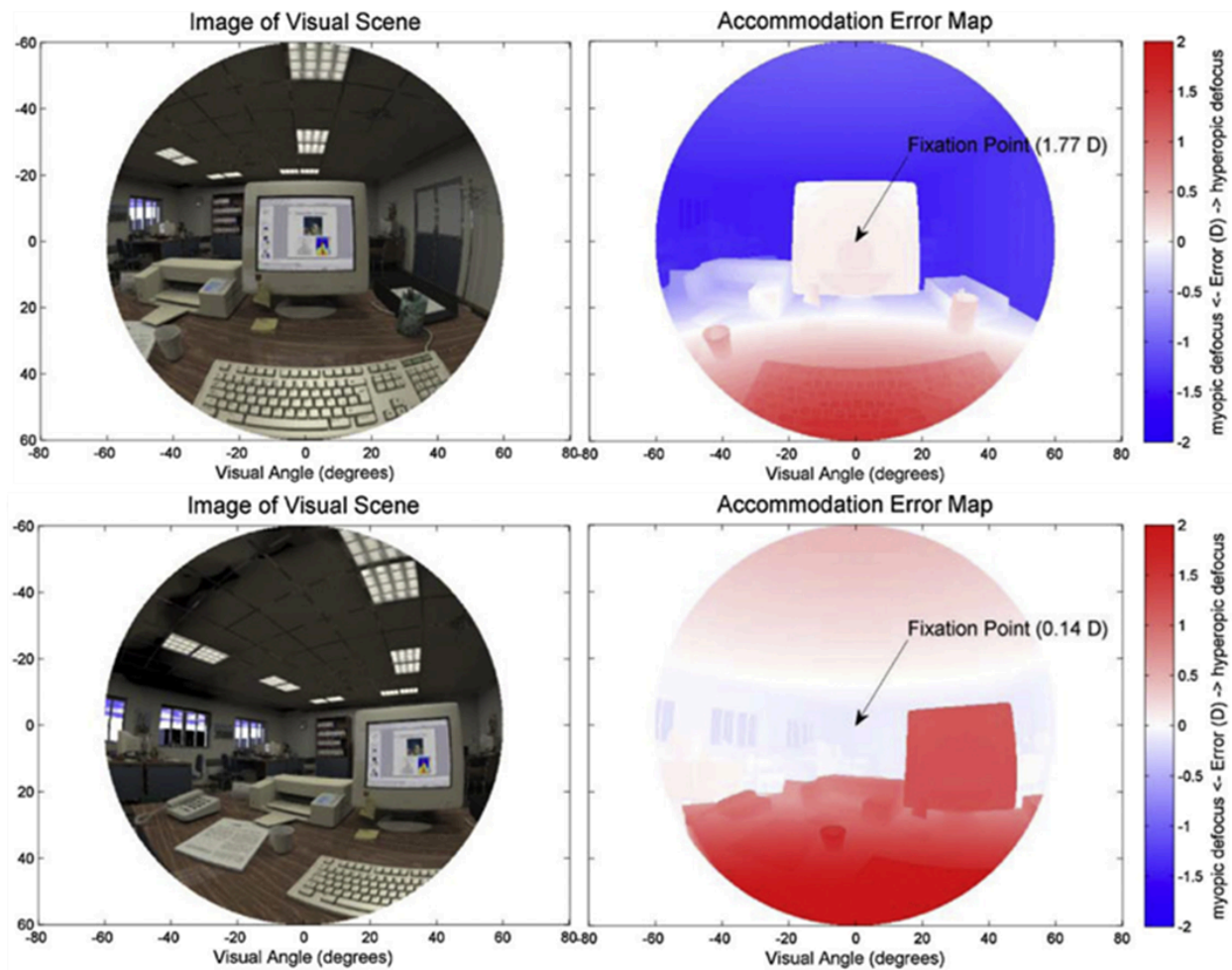


Figure 2: Dioptric error maps highlighting that eye elongation patterns are closely linked to the spatial distribution of retinal defocus [1].

Accommodation Lag and Hyperopic Defocus

Accommodation lag—a slight delay or insufficiency in the eye's focusing ability—means that even central vision during near work can be hyperopically defocused, especially in myopic individuals [9-11]. This creates central retinal blur, further reinforcing the biological triggers for eye growth. The most vulnerable populations are children and adolescents, whose eyes are still in the critical stages of emmetropization [12, 13]. Animal studies and human cohort data suggest that just a few hours of hyperopic defocus per day can accelerate axial growth, especially in younger eyes [5, 14].

The Depth Challenge in AR/VR and 3D Displays

AR and VR systems add another dimension to the problem. While traditional flat screens require constant near accommodation, ARVR tech struggles with the accommodation-vergence conflict. In real-world vision, vergence (eye turning) and

accommodation (focusing) are coordinated and reinforce each other. But in most VR and AR systems, the eyes converge on virtual depth planes while the focal demand remains at the fixed distance of the headset's optics (see Fig. 3). This **accommodation-vergence mismatch** is unnatural and leads to visual fatigue, blur, and—potentially—long-term refractive consequences if used extensively [15-17]. Such systems can worsen symptoms of **digital eye strain** and do not adequately stimulate the natural range of depth focus needed for healthy visual development. Moreover, conventional VR displays still present significant **peripheral hyperopic defocus**, which can continue to promote eye elongation, particularly in growing eyes [14, 18].

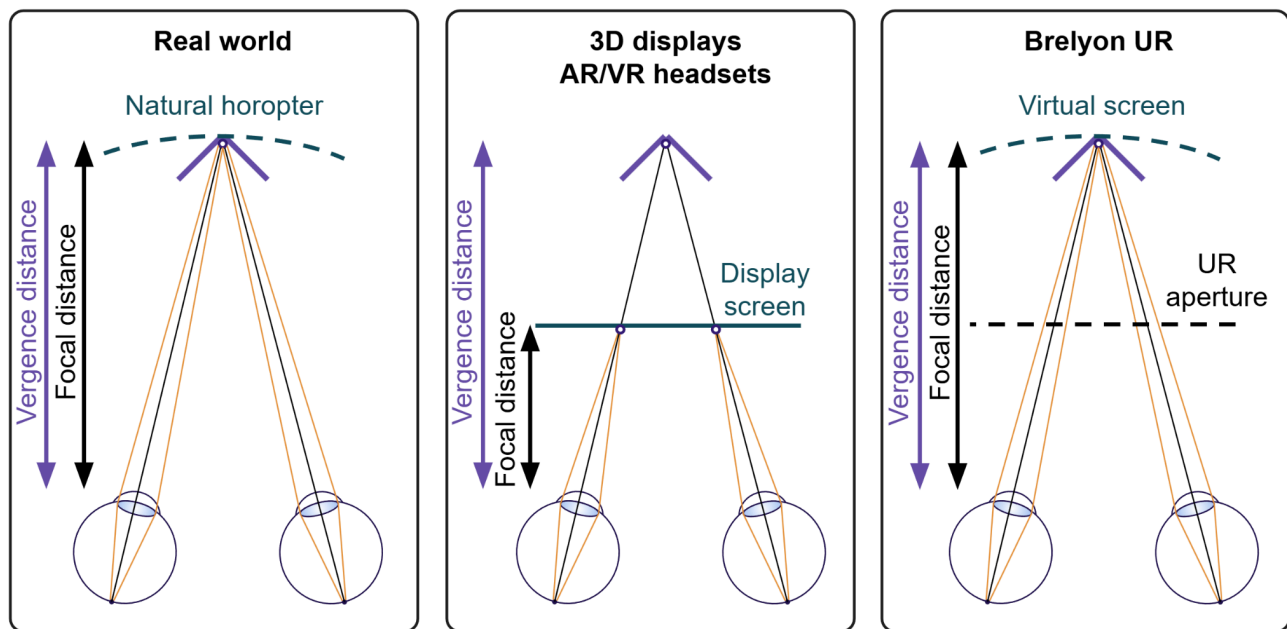


Figure 3: Schematic illustration of accommodation-vergence mismatch in AR/VR systems versus a close-to-natural peripheral focus pattern in Brelyon displays.

The Discomfort of Hyperopic Defocus

Beyond long-term eye growth, hyperopic defocus is **perceptually unpleasant**. It's associated with symptoms like:

- Blurry peripheral vision
- Eye strain and fatigue
- Headaches, particularly with prolonged close work

This discomfort is especially prominent in digital environments where visual ergonomics are suboptimal. Even among adults, sustained focus at short distances has been linked with **digital eye strain**, sometimes called computer vision syndrome [14, 18].

How Brelyon's Technology Alters the Visual Equation

Brelyon's light-field display systems provide a radically different approach. By simulating a **panoramic virtual screen with real depth cues at farther depths**, Brelyon displays reduce the demand for extreme convergence and encourage **naturalistic depth perception** [19]. In essence, our displays push your depth cues farther away, making near work feel less near (see Fig. 4). This allows users to engage in visually intensive tasks without the typical strain associated with close-up screens. Our displays can present different depth planes more realistically—without headsets—way.



Figure 4: Ultra Reality Extend, the world's first multi-focal monitor, [Brelyon](#).

This matters for several reasons:

- **Reduced Near Lag of Accommodation:** Because virtual images can appear at mid or far distances, the eyes can relax more, reducing the lag that drives central hyperopic defocus.
- **Peripheral Focus Consistency:** Our light-field technology minimizes abrupt gradients in peripheral defocus by offering a virtual image closer to the natural horopter than what is seen in traditional near displays (see the right panel in Fig. 3).

- **Decreased Visual Fatigue:** The lack of accommodation-vergence conflict—common in headset-based systems—leads to more comfortable and sustainable viewing sessions, potentially helping maintain or even enhance acuity reserve, i.e., the ability of the eye to see fine details.[20].

Together, these changes might help reduce some of the optical conditions that promote myopia progression, particularly in professional or prolonged use settings.

Fig. 5 illustrates the ranking of display technologies by accommodation-vergence mismatch and accommodation error—from projector to AR—that reflects the degree to which each system disrupts the natural coupling between where the eyes converge (vergence) and where they focus (accommodation). Projectors and TVs, positioned several meters away, offer fixed and consistent vergence and accommodation cues, closely matching real-world viewing and minimizing visual fatigue. Brelyon displays, although closer than projectors or TVs, simulate distant focal points through light field manipulation, preserving a more natural depth experience. Monitors, tablets, and cell phones progressively reduce the viewing distance while still providing a fixed accommodation point, increasing the likelihood of vergence-accommodation conflict. IMAX 3D introduces artificial depth via binocular disparity while the screen remains several meters away, keeping the accommodation cue fixed, yet inducing moderate conflict. In autostereoscopic displays (e.g., glasses-free 3D), viewers sit closer to the screen, but the displayed 3D images may appear to be much farther away, increasing mismatch due to conflicting vergence and accommodation cues. VR and AR headsets bring the physical screen extremely close to the eyes, but simulate a wide range of depths. This results in a range of vergence-accommodation mismatches, since the eyes must converge on virtual depths while continuing to accommodate at the near physical screen, leading to the highest levels of mismatch and visual discomfort (see Fig. 3).

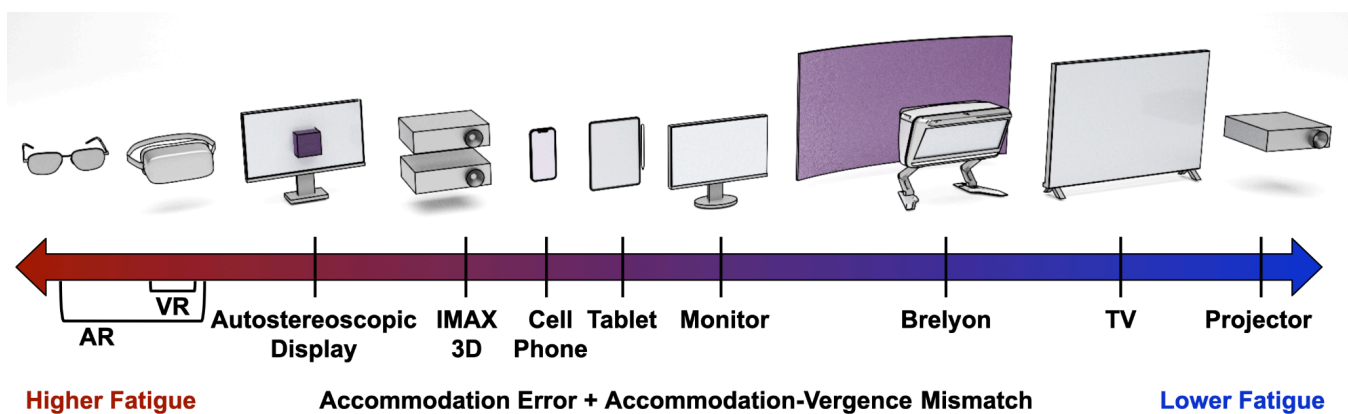


Figure 5: Comparison of display technologies in terms of the accommodation error and accommodation-vergence mismatch.

Scientific Consensus and Practical Advice

Numerous longitudinal and cross-sectional studies support interventions such as:

- Increasing outdoor time (2+ hours/day) [8]
- Limiting continuous near work sessions [10, 11]
- Maintaining working distances of at least 40 cm [4, 9]
- Using display systems that reduce the need for accommodation or encourage far-distance viewing [21]

Brelyon's display systems align with these principles not by making **sustained visual tasks more compatible** with them. Our immersive screens allow for expansive, natural viewing fields—supporting a less stressful visual environment.

Conclusion

The rise of myopia is a modern public health issue, driven in large part by our visual behaviors and environments. Although technology plays a major role in driving this epidemic, it also offers a potential path forward.

By integrating depth-aware optical systems, minimizing accommodation-vergence conflict, and reducing peripheral hyperopic defocus, display technologies like those developed at Brelyon might support healthier visual habits and reduce long-term myopia risk—especially in settings where screen use is unavoidable.

We believe the future of immersive display isn't just about better visuals—it's also about better visual health.

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