The *Error Lens* Concept

*Basic Optics*, Chapter 8
Another way of thinking about refractive error
The Error Lens Concept

The Myopic Eye

Parallel rays from infinity (vergence = 0)

We have noted that the refractive error of a myopic eye can be thought of as resulting from excess converging power. To ‘explain’ this extra convergence...
The **Error Lens** Concept

The Myopic Eye

*It’s as if the myopic eye has an extra ‘plus’ lens within it that’s causing the refractive error*

The myopic eye has **too much converging power for its length**

Parallel rays from infinity (vergence = 0)

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We have noted that the refractive error of a myopic eye can be thought of as resulting from excess converging power. To ‘explain’ this extra convergence… We can think of it as resulting from an extra (as in extraneous or unneeded) *plus* lens built into the myopic eye. **It is this extra plus lens that causes the excess convergence that results in the myopic refractive error.**
The Myopic Eye

It’s as if the myopic eye has an extra ‘plus’ lens within it that’s causing the refractive error.

The myopic eye has too much converging power for its length.

Parallel rays from infinity (vergence = 0)

We have noted that the refractive error of a myopic eye can be thought of as resulting from excess converging power. To ‘explain’ this extra convergence… We can think of it as resulting from an extra (as in extraneous or unneeded) plus lens built into the myopic eye. It is this extra plus lens that causes the excess convergence that results in the myopic refractive error.

This is the concept of the Error Lens
The Myopic Eye

It’s as if the myopic eye has an extra ‘plus’ lens within it that’s causing the refractive error. The myopic eye has too much converging power for its length.

Parallel rays from infinity (vergence = 0)

The error-lens concept explains why a myopic eye requires a minus lens to correct its refractive error—the minus lens is needed to counteract the excess convergence provided by the plus error lens.

This is the concept of the Error Lens.
The Hyperopic Eye

The hyperopic eye has too little converging power for its length

Parallel rays from infinity (vergence = 0)

We have noted that the refractive error of a hyperopic eye can be thought of as resulting from too little converging power. However…
The Hyperopic Eye

Parallel rays from infinity (vergence = 0)

We have noted that the refractive error of a hyperopic eye can be thought of as resulting from too little converging power. However… We could also describe it as resulting from excess diverging power. To ‘explain’ this extra divergence…
We have noted that the refractive error of a hyperopic eye can be thought of as resulting from too little converging power. However… We could also describe it as resulting from excess diverging power. To ‘explain’ this extra divergence… We can think of it as resulting from an extra minus lens built into the hyperopic eye. It is this extra minus lens that causes the excess divergence that results in the hyperopic refractive error.
The *Error Lens Concept*

The Hyperopic Eye

It's as if the hyperopic eye has an extra ‘minus’ lens within it that's causing the refractive error.

Parallel rays from infinity (vergence = 0)

The error-lens concept explains why a hyperopic eye requires a plus lens to correct its refractive error—the plus lens is needed to counteract the excess divergence of the *minus* error lens.
The *Error Lens* Concept

**Hyperopic Eye**

Eye Error Lens: -2D

**Myopic Eye**

Eye Error Lens: +4
To offset the error lens, the corrective lens needs to be of equal but opposite power (except for whatever adjustment is needed to account for the vertex distance).
Note that spectacle-corrected hyperopes and myopes are looking through both a plus \textbf{and} a minus lens—the only difference is the order in which these lenses are ‘placed’ in front of the eye.

Can you think of a common optical device that is composed of a plus lens and minus lens?
Note that spectacle-corrected hyperopes and myopes are looking through both a plus and a minus lens—the only difference is the order in which these lenses are ‘placed’ in front of the eye.

Can you think of a common optical device that is composed of a plus lens and minus lens? A Galilean telescope is composed of a low-plus objective lens and a high-minus eyepiece lens. So why bring this up now? What’s the relevance to refractive correction?
Note that spectacle-corrected hyperopes and myopes are looking through both a plus and a minus lens—the only difference is the order in which these lenses are ‘placed’ in front of the eye.

Can you think of a common optical device that is composed of a plus lens and minus lens? A Galilean telescope is composed of a low-plus objective lens and a high-minus eyepiece lens. So why bring this up now? What’s the relevance to refractive correction? It explains the image magnification/minification effects of refractive correction. Because a spectacle-corrected hyperope is, in essence, looking through a Galilean telescope, the image is magnified. In contrast, because a myope is looking through a Galilean telescope backwards, the image is minified.
The *Error Lens* Concept

Note that spectacle-corrected hyperopes and myopes are looking through both a plus and a minus lens—the only difference is the order in which these lenses are ‘placed’ in front of the eye.

Can you think of a common optical device that is composed of a plus lens and minus lens? A Galilean telescope is composed of a low-plus objective lens and a high-minus eyepiece lens. So why bring this up now? What’s the relevance to refractive correction? It explains the image magnification/minification effects of refractive correction. Because a spectacle-corrected hyperope is looking through a Galilean telescope, the image is magnified. In contrast, because a myope is looking through a Galilean telescope backwards, the image is minified.

By the way, telescopes are very much-in play on the OKAPs! We will discuss magnification/minification, as well as Galilean (and other) telescopes, at length in a future chapter.

Parallel rays from an object at infinity

Galilean (terrestrial) telescope

Parallel rays to an image at infinity
The *Error Lens* Concept

The Hyperopic Eye

The Emmetropic Eye

The Myopic Eye

We saw this slide in Chapter 5. Did you wonder why the primary focal points were at different distances from the eye?
We saw this slide in Chapter 5. Did you wonder why the primary focal points were at different distances from the eye? The error lens concept provides a nice explanation. Compared to the emmetropic eye, the myopic eye has excess convergence owing to its extra plus lens. Thus, the primary focal point of the myopic eye must be closer in order to provide the extra divergence needed to offset the plus error lens. Likewise, the minus error lens of the hyperopic eye gives it less converging power than the emmetropic eye, so as a result it needs less offsetting divergence from its primary focal point.