Jump and Displacement

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- Image jump and image displacement are phenomena associated with bifocal additions
- **Not** an issue with PALs (progressive addition lenses; i.e., no-line bifocals)
- Before delving into jump and displacement, let’s talk about some background info:
  - Lenses as prisms
  - Types of bifocal add segments
  - Optical centers
  - Prentice’s rule of induced prism
Spherical lenses come in two basic flavors: *Plus* and *minus*
Lenses as Prisms

Recall that a *plus* lens can be thought of as two prisms *base-to-base*.

Spherical lenses come in two basic flavors: *Plus* and *minus*.
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Spherical lenses come in two basic flavors: *Plus* and *minus*.

Likewise, a *minus* lens can be thought of as two prisms **apex-to-apex**.
Types of Add Segments

Bifocal adds come in two basic flavors: *Round top* and *flat top*. 
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A **round-top** bifocal segment can be thought of as the **top half** of a plus lens (and thus like a **base-down** prism)
Bifocal adds come in two basic flavors: **Round top** and **flat top**

A **round-top** bifocal segment can be thought of as the **top half** of a plus lens (and thus like a **base-down** prism).

Likewise, a **flat-top** bifocal segment can be thought of as the **bottom half** of a plus lens (i.e., a **base-up** prism).
Lenses: Optical Centers

The optical center of the **plus** lens is right here, in the center.

**Spherical lenses** come in two basic flavors: **Plus** and **minus**.
**Lenses: Optical Centers**

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The optical center of the **minus** lens is right here, in the center.
Spherical lenses come in two basic flavors: *Plus* and *minus*.

The optical center of the **plus** lens is right here, in the center.

The optical center of the **minus** lens is right here, in the center.

*The optical center of the add is near its base; i.e., near where it would be if the add were a ‘whole’ plus lens instead of half of one.*
Lenses: Optical Centers

The optical center of the **plus** lens is right here, in the center.

**Spherical lenses** come in two basic flavors: *Plus* and *minus*.

The optical center of the **minus** lens is right here, in the center.

On a **round-top** add, the optical center of the add is **low**.

The optical center of the add is near its base; *i.e.*, near where it would be if the add were a ‘whole’ plus lens instead of half of one.
Lenses: Optical Centers

The optical center of the **plus** lens is right here, in the center.

**Spherical lenses** come in two basic flavors: **Plus** and **minus**.

The optical center of the **minus** lens is right here, in the center.

On a **round-top** add, the optical center of the add is **low**.

The optical center of the add is near its base; i.e., near where it would be if the add were a ‘whole’ plus lens instead of half of one.

On a **flat-top** add, the optical center of the add is **high**.
Because lenses are fundamentally prisms, it is not surprising that lenses can have prismatic effects. **Prentice’s Rule** states that the amount of prism (in prism diopters, PD) induced by a lens is a function of the distance from the optical center through which one is looking, and the dioptric power of the lens:

\[ PD = hD \]

where \( h \) is the distance from the optical center in cm and \( D \) is the dioptric power of the lens.
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where **h is the distance from the optical center in cm** and **D is the dioptric power of the lens**.

Make sure you take note of this!
Because lenses are fundamentally prisms, it is not surprising that lenses can have prismatic effects. **Prentice’s Rule** states that the amount of prism (in prism diopters, PD) induced by a lens is a function of the distance from the optical center through which one is looking, and the dioptric power of the lens:

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Looking 5 mm below the optical center of a -3D lens induces .5 x (-3) = 1.5D of base-down prism.
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Looking 5 mm below the optical center of a -3D lens induces \( 0.5 \times (-3) = 1.5 \)D of base-down prism.

Looking 5 mm below the optical center of a +3D lens induces \( 0.5 \times (3) = 1.5 \)D of base-up prism.
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Looking 5 mm below the optical center of a +3D lens induces \(.5 \times (3) = 1.5D\) of base-up prism.

Recall that light rays are bent toward the base of a prism, with the result that the image seems to move toward the apex of the prism…
Image *Jump*

- *Image jump* refers to a **sudden** change in image location that occurs when gaze shifts from the distance lens to the add segment.
Image Jump

- *Image jump* refers to a **sudden** change in image location that occurs when gaze shifts from the distance lens to the add segment.
- Think of it as a **Prentice’s Rule** issue owing to the location of the **optical center** of the add segment.
Image Jump

Bifocal add: Flat-Top segment

The optical center of a flat-top segment is high. When gaze shifts downward into the add, one is looking through or very near its optical center. Because there is little or no induced prism (i.e., \( h \) is small or zero), images do not seem to jump.

**Image jump:** A sudden change in image location occurring when gaze shifts into the bifocal add segment
The optical center of a flat-top segment is high. When gaze shifts downward into the add, one is looking through or very near its optical center. Because there is little or no induced prism (i.e., $h$ is small or zero), images do not seem to jump.

However, the optical center of a round-top segment is low. Therefore, when gaze shifts downward into the add, one is suddenly looking through a lens at considerable distance from its optical center (i.e., $h$ is large). This abruptly induces a significant amount of prism, and images will seem to jump (upwards, toward the apex of the add segment ‘prism’).
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Therefore, for both plus and minus lenses, image jump is minimized with a flat-top segment.
Image Displacement

- *Image displacement* refers to the total apparent distance between an image viewed through the distance lens versus through the add segment.
Image Displacement

- Image displacement refers to the total apparent distance between an image viewed through the distance lens versus through the add segment
- Think of it as owing to net prismatic effects
  - The magnitude of image displacement is a function of the total net prism acting on the image through the bifocal segment
Image Displacement

The magnitude of image displacement is a function of the total net prism acting on the image through the bifocal segment.
Image Displacement

Bifocal adds: *Plus* lenses

When a round-top segment is placed on a plus lens, note how the prismatic effects work to cancel each other:

\[ BU + BD = \text{Little net prism} \rightarrow \text{little image displacement} \]

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Image Displacement

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When a **round-top** segment is placed on a plus lens, note how the prismatic effects work to cancel each other

\[ BU + BD = \text{Little net prism} \rightarrow \text{little image displacement} \]

However, when a **flat-top** segment is placed on a plus lens, note how the prismatic effect is amplified

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*For a plus lens, image displacement is minimized with a **round-top** segment.*
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Bifocal adds: **Minus** lenses

When a **round-top** segment is placed on a minus lens, note how the prismatic effects amplify one another.

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The magnitude of image displacement is a function of the **total net prism** acting on the image through the bifocal segment.

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However, when a **flat-top** segment is placed on a minus lens, the prismatic effects work to cancel one another.

\[ BD + BU = \text{Little net prism} \rightarrow \text{little image displacement} \]

**For a minus lens, image displacement is minimized with a **flat-top** segment.**

The magnitude of image displacement is a function of the **total net prism** acting on the image through the bifocal segment.
Putting It Together: Which Add Is Best?
As stated previously, a flat-top segment minimizes image jump for both plus and minus lenses.
Putting It Together: Which Add Is Best?

Bifocal adds: **Minus** lenses

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Bifocal adds: **Plus** lenses

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Putting It Together: Which Add Is Best?

Bifocal adds: **Minus** lenses

A flat-top segment minimizes image jump

So, for minus lenses the choice of add type is easy: A flat-top minimizes both image jump and displacement

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For a minus lens, always select a flat-top segment
For a **minus** lens, always select a **flat-top** segment

**Bifocal adds:**

- **Minus** lenses

  A **flat-top** segment minimizes image jump

  So, for **minus** lenses the choice of add type is easy: **A flat-top minimizes both image jump and displacement**

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**Bifocal adds:**

- **Plus** lenses

  A **flat-top** segment minimizes image jump

  For **plus** lenses, the choice is not as easy: **A flat-top will minimize jump…**
 Putting It Together: Which Add Is Best?

Bifocal adds: **Minus** lenses

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So, for **minus lenses** the choice of add type is easy: A flat-top minimizes both image jump and displacement

When a **flat-top** segment is placed on a minus lens, the prismatic effects work to cancel one another

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**For a minus lens, always select a flat-top segment**

Bifocal adds: **Plus** lenses

A **flat-top** segment minimizes image jump

For **plus lenses**, the choice is not as easy: A flat-top will minimize jump...but a round-top minimizes displacement

When a **round-top** segment is placed on a plus lens, the prismatic effects work to cancel each other

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For a **minus** lens, always select a **flat-top** segment

Bifocal adds: **Plus** lenses

A **flat-top** segment minimizes image jump

For **plus** lenses, the choice is not as easy: A flat-top will minimize jump...but a round-top minimizes displacement

When a **round-top** segment is placed on a plus lens, the prismatic effects work to cancel each other

\[ BU + BD = \text{Little net prism} \rightarrow \text{little image displacement} \]

So which is the best add segment for a **plus** lens?
The choice of segment type for hyperopic adds depends on whether one needs to minimize jump vs displacement.

Bifocal adds: *Plus* lenses

- **Flat-top** segment minimizes image jump.
- For plus lenses, the choice is not as easy: a flat-top will minimize jump...but a round-top minimizes displacement.
- When a round-top segment is placed on a plus lens, the prismatic effects work to cancel each other.

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So which is the best add segment for a plus lens?
Putting It Together: Which Add Is Best?

- The choice of segment type for hyperopic adds depends on whether one needs to minimize jump vs displacement
  - *Jump* might bother waiters
  - *Displacement* might bother desk workers

For plus lenses, the choice is not as easy: A flat-top will minimize jump…but a round-top minimizes displacement

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So which is the best add segment for a plus lens?
The choice of segment type for hyperopic adds depends on whether one needs to minimize jump vs displacement:
- *Jump* might bother waiters
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In practice, most specs are made with flat-top segs:
- Easier and cheaper to make

**Bifocal adds:** *Plus* lenses

A flat-top segment minimizes image jump:
For plus lenses, the choice is not as easy: A flat-top will minimize jump... but a round-top minimizes displacement when a round-top segment is placed on a plus lens, the prismatic effects work to cancel each other.

So which is the best add segment for a *plus* lens?