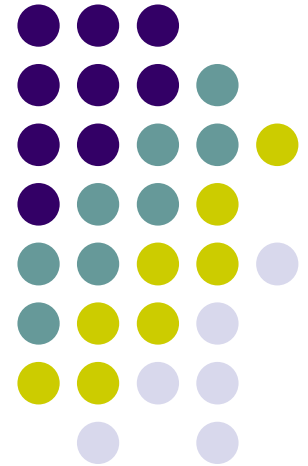


Bifocal Add: Image Jump and Image Displacement

Basic Optics, Chapter 24

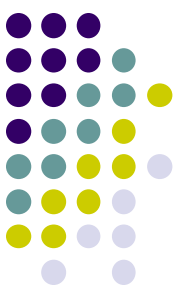


Jump and Displacement

- Image jump and image displacement are phenomena associated with bifocal additions



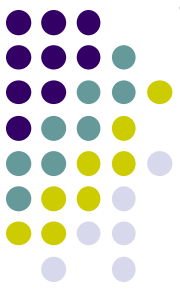
Jump and Displacement



- Image jump and image displacement are phenomena associated with bifocal additions
- **Not** an issue with PALs (progressive addition lenses; i.e., no-line bifocals*)

*Be aware that, because they aren't limited to two focal distances, the appellation *no-line bifocals* is technically incorrect (not to mention a contradiction in terms).

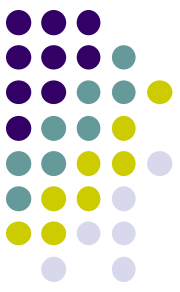
Jump and Displacement



- Image jump and image displacement are phenomena associated with bifocal additions
- **Not** an issue with PALs (progressive addition lenses; i.e., no-line bifocals*)

*Be aware that, because they aren't limited to two focal distances, the appellation *no-line bifocals* is technically incorrect (not to mention a contradiction in terms). The point being, if an OKAP question asks about 'presbyopia-correcting lenses,' then PALs are in play. *But if the question refers to "bifocals" specifically, the answer is never PALs (cuz they ain't bifocals).*

Jump and Displacement



- 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

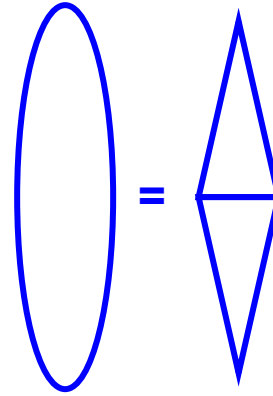
Lenses as Prisms



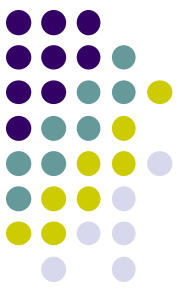
Spherical lenses come in two basic flavors: *Plus* and *minus*

Lenses as Prisms

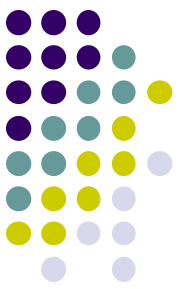
Recall that a *plus* lens can be thought of as two prisms **base-to-base**



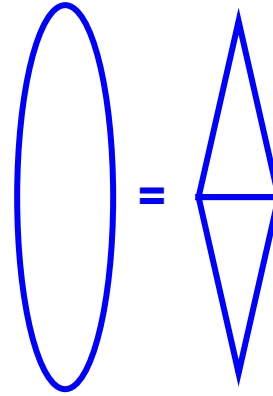
Spherical lenses come in two basic flavors: ***Plus*** and *minus*



Lenses as Prisms

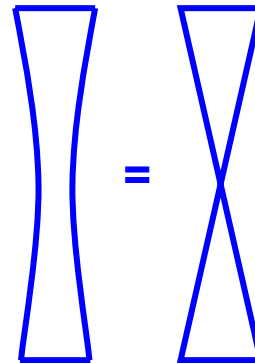


Recall that a *plus* lens can be thought of as two prisms **base-to-base**



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

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

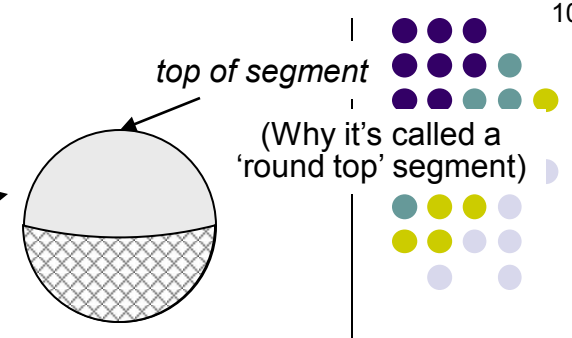
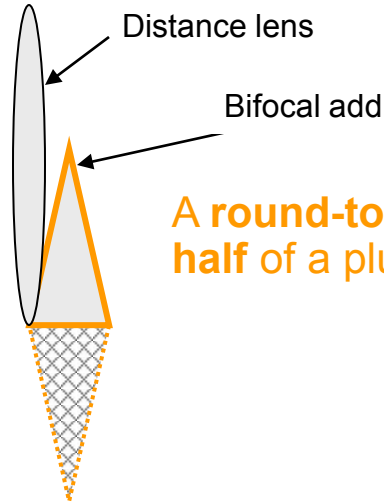


Types of Add Segments



Bifocal adds come in two basic flavors: *Round top* and *flat top*

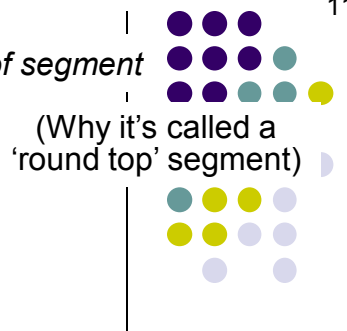
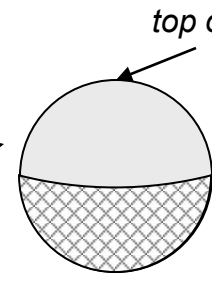
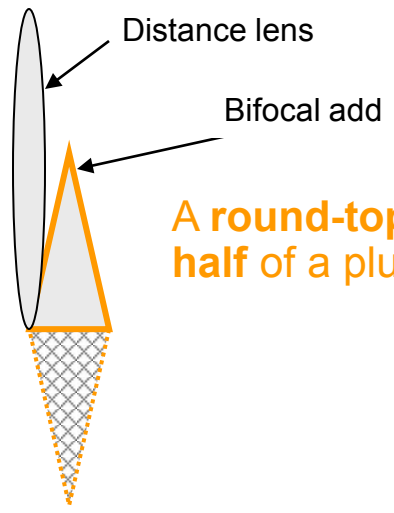
Types of Add Segments



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

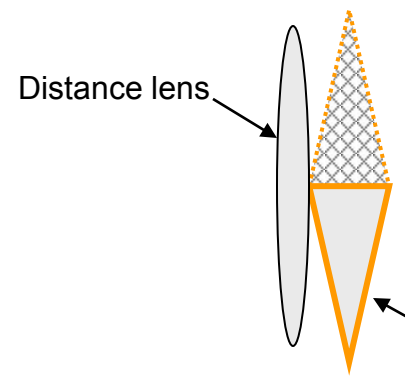
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Types of Add Segments

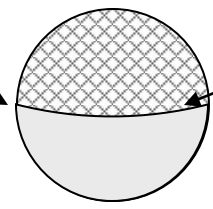


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Bifocal adds come in two basic flavors: *Round top* and **flat top**

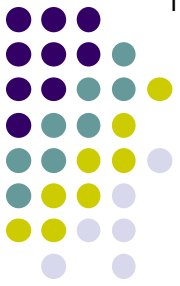


Likewise, a **flat-top** bifocal segment can be thought of as the **bottom half** of a plus lens (i.e., a **base-up** prism)

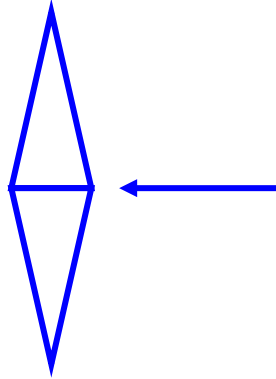


(Why it's called a 'flat top' segment)

Lenses: Optical Centers

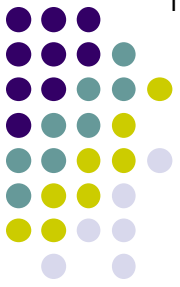


The optical center of the **plus** lens is right here, in the center

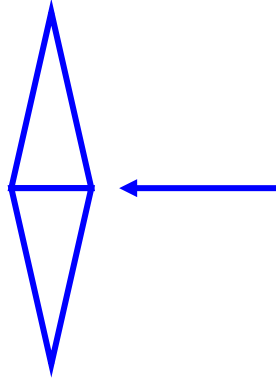


Spherical lenses come in two basic flavors: ***Plus*** and ***minus***

Lenses: Optical Centers

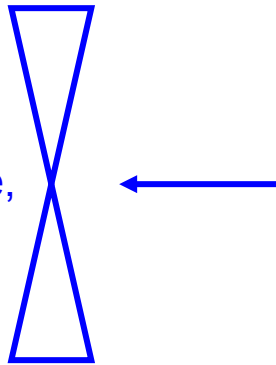


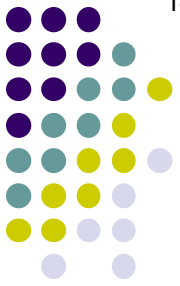
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Spherical lenses come in two basic flavors: *Plus* and *minus*

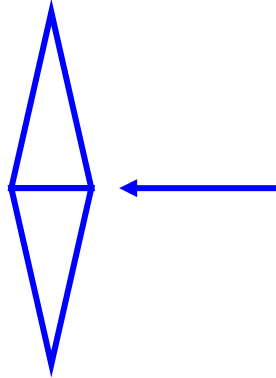
The optical center of the **minus** lens is right here, in the center





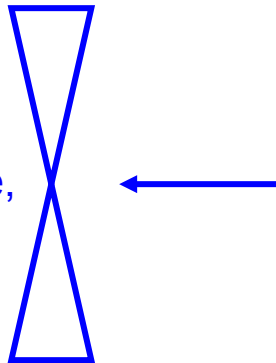
Lenses: Optical Centers

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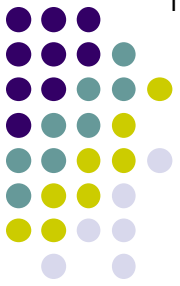
Spherical lenses come in two basic flavors: *Plus* and *minus*

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

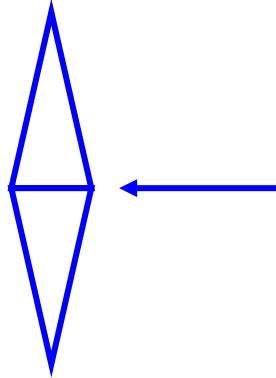


The optical center of the add is near its base; i.e., near where it would be if the add were a 'whole' plus lens instead of half of one

Lenses: Optical Centers

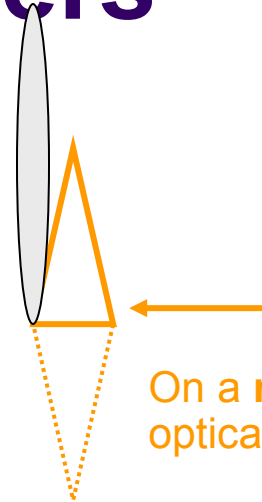
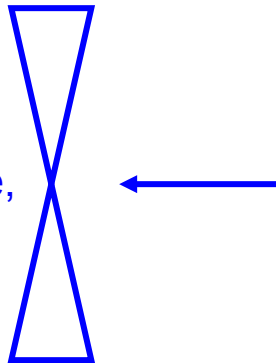


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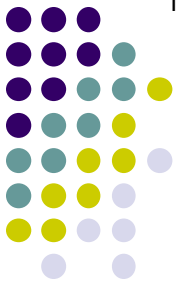
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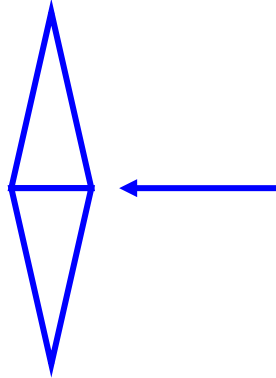
On a **round-top** add, the optical center of the add is **low**

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Lenses: Optical Centers

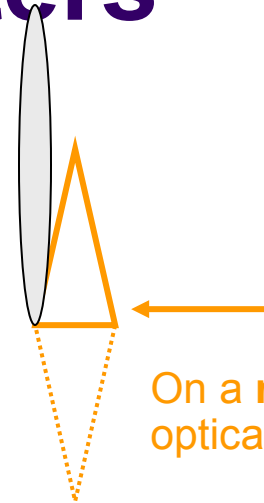
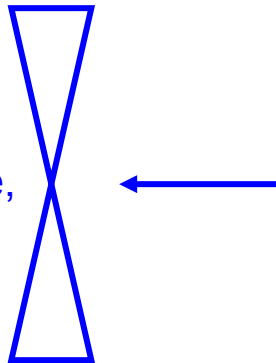


The optical center of the **plus** lens is right here, in the center



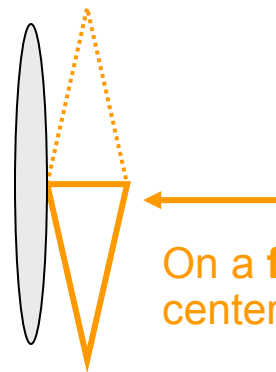
Spherical lenses come in two basic flavors: *Plus* and *minus*

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**

Prentice's Rule of Induced Prism



*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!

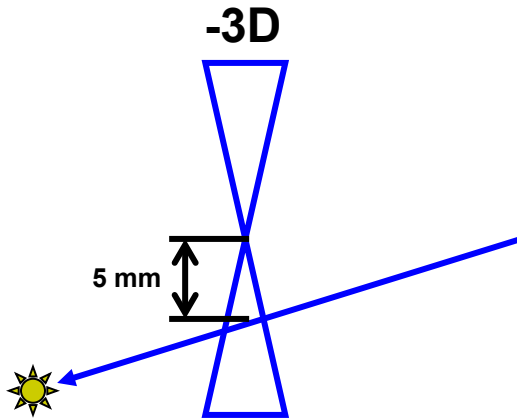
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Looking 5 mm below the optical center of a -3D lens induces $.5 \times (-3) = 1.5D$ of base-**down** prism

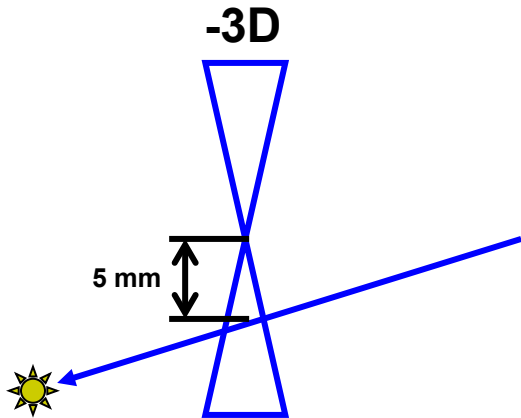
Prentice's Rule of Induced Prism



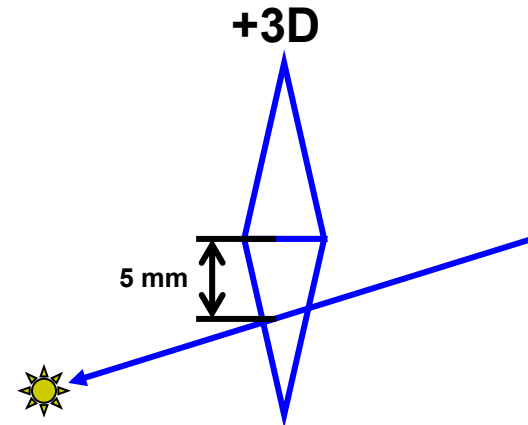
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Looking 5 mm below the optical center of a +3D lens induces $.5 \times (3) = 1.5D$ of base-**up** prism

Prentice's Rule of Induced Prism

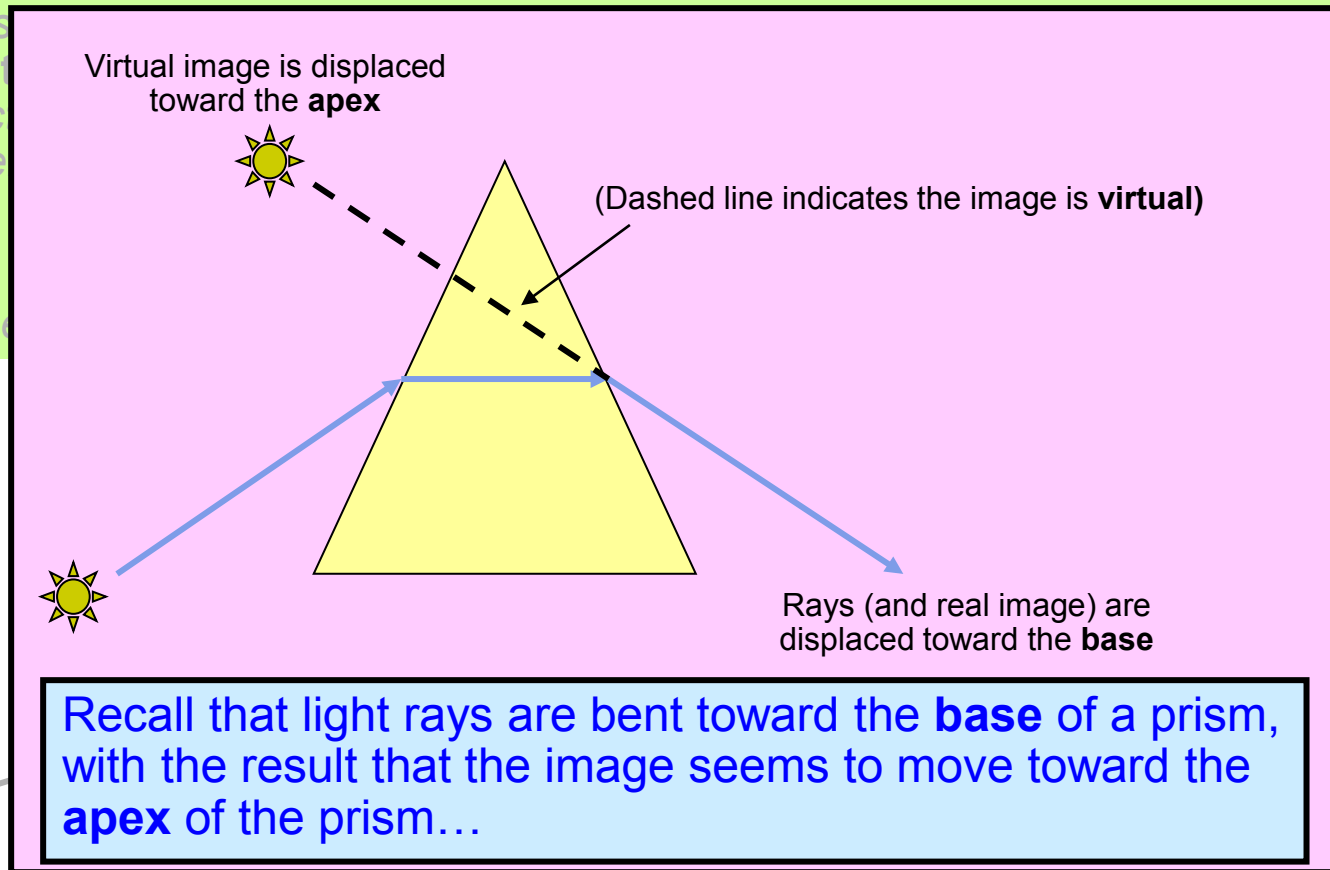


Because lens effects. Prentice's rule is a function of the dioptric power

where h is the

prismatic effect induced by a lens, and the

the lens.



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

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

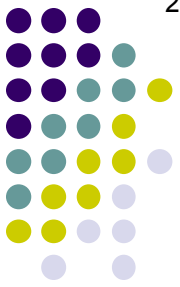


Image Jump

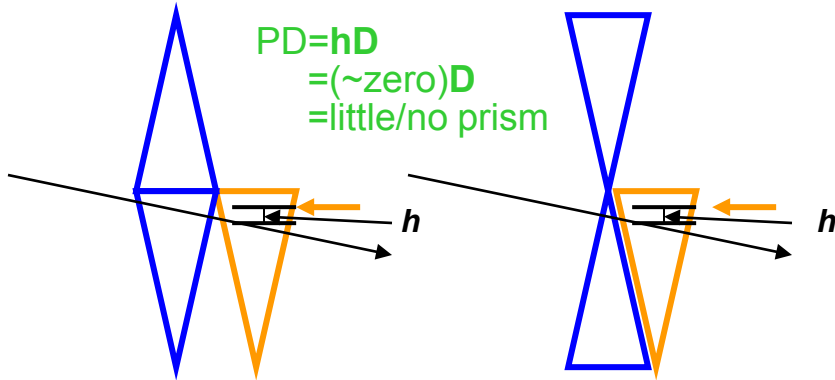


- *Image jump* refers to a **sudden** change in image location that occurs when gaze shifts from the distance lens to the add segment
 - Think of it as a **Prentice's Rule** issue owing to the location of the **optical center** of the add segment

Image Jump

Bifocal add:

Flat-Top segment



The optical center of a **flat-top** segment is high*.

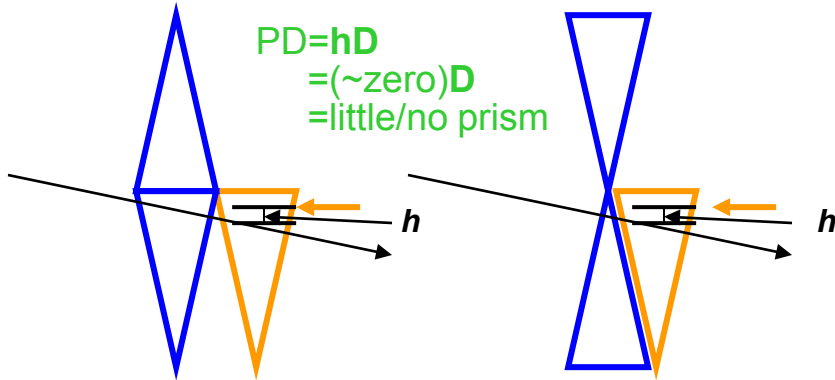
Image jump: A sudden change in image location occurring when gaze shifts into the bifocal add segment

*Per the BCSC *Optics* book, the optical center of a typical flat-top is 3 mm from the top of the segment.

Image Jump

Bifocal add:

Flat-Top segment



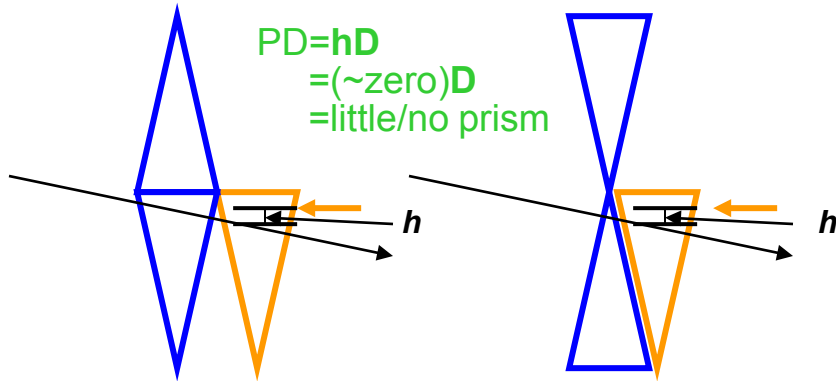
The optical center of a **flat-top** segment is **high**. When gaze shifts downward into the add, one is looking very near its optical center. Because there is little induced prism (i.e., ***h*** is small), images do not seem to jump.

Image jump: A sudden change in image location occurring when gaze shifts into the bifocal add segment

Image Jump

Bifocal add:

Flat-Top segment

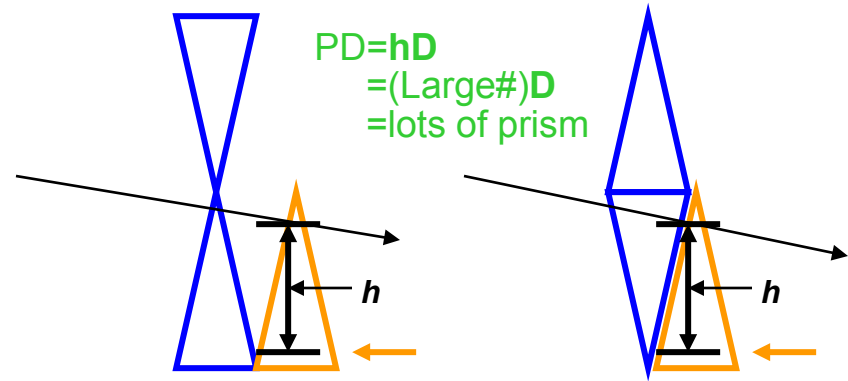


The optical center of a **flat-top** segment is high. When gaze shifts downward into the add, one is looking very near its optical center. Because there is little induced prism (i.e., h is small), images do not seem to jump.

Image jump: A sudden change in image location occurring when gaze shifts into the bifocal add segment

Bifocal add:

Round-Top segment



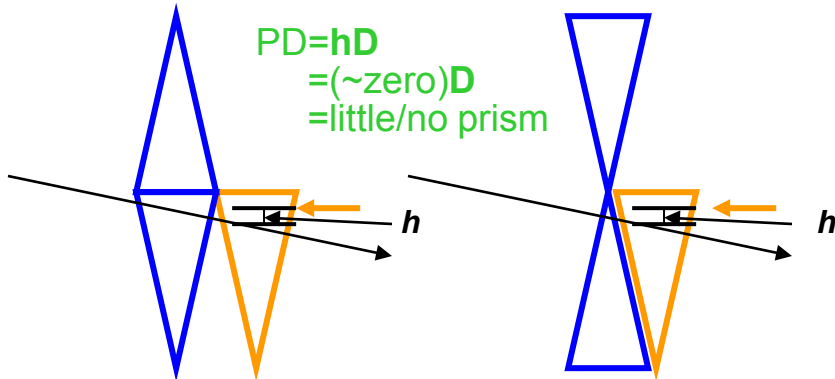
However, the optical center of a **round-top** segment is low*.

*The *Optics* book does not offer a specific value for the typical segment-top-to-optical-center distance on a round-top.

Image Jump

Bifocal add:

Flat-Top segment

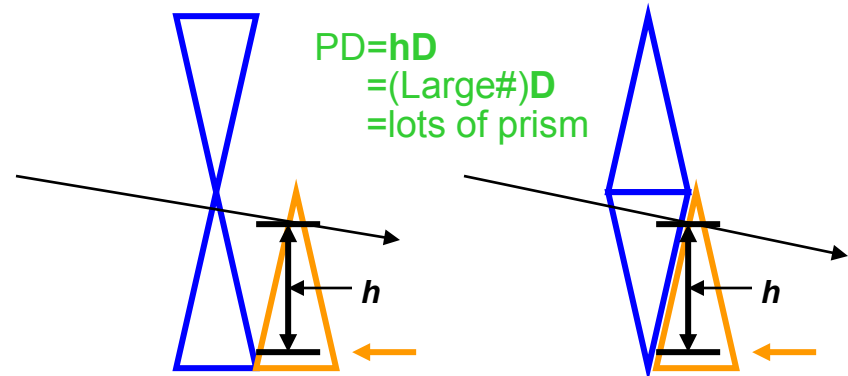


The optical center of a **flat-top** segment is **high**. When gaze shifts downward into the add, one is looking very near its optical center. Because there is little induced prism (i.e., h is small), images do not seem to jump.

Image jump: A sudden change in image location occurring when gaze shifts into the bifocal add segment

Bifocal add:

Round-Top segment



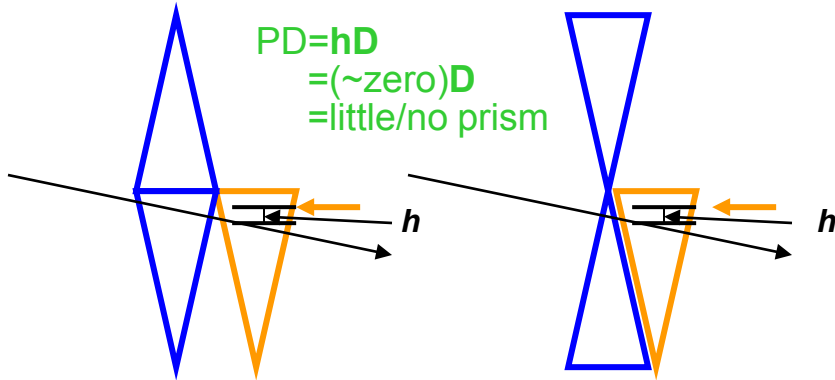
However, the optical center of a **round-top** segment is **low**. Therefore, when gaze shifts downward into the add, one is suddenly looking through a lens at considerable distance from its optical center (i.e., h is large). This abruptly induces a significant amount of prism, and images will seem to jump (*upwards*, toward the apex of the add segment 'prism').

Image Jump

Image jump: A sudden change in image location occurring when gaze shifts into the bifocal add segment

Bifocal add:

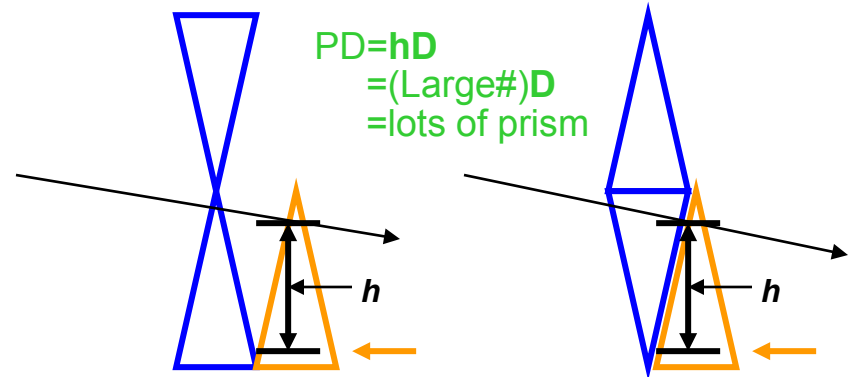
Flat-Top segment



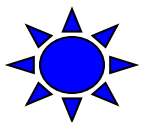
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However, the optical center of a **round-top** segment is **low**. Therefore, when gaze shifts downward into the add, one is suddenly looking through a lens at considerable distance from its optical center (i.e., h is large). This abruptly induces a significant amount of prism, and images will seem to jump (*upwards*, toward the apex of the add segment 'prism').



Therefore, for both plus and minus lenses, image jump is minimized with a **flat-top** segment

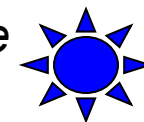
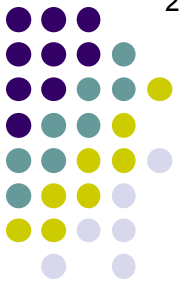


Image Jump



A final note related to image jump...

There is a third, rarely dispensed bifocal flavor:
The *Executive* or *Franklin** type

*Yes, *that* Franklin

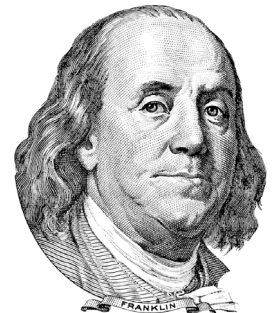
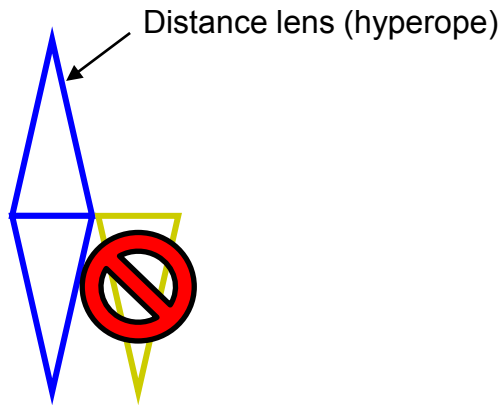


Image Jump



Executive/Franklin bifocals are not created by affixing a flat- or round-top seg to a base distance lens

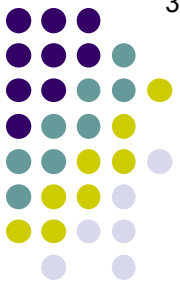
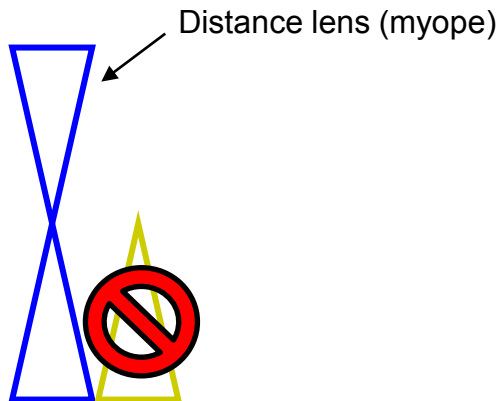
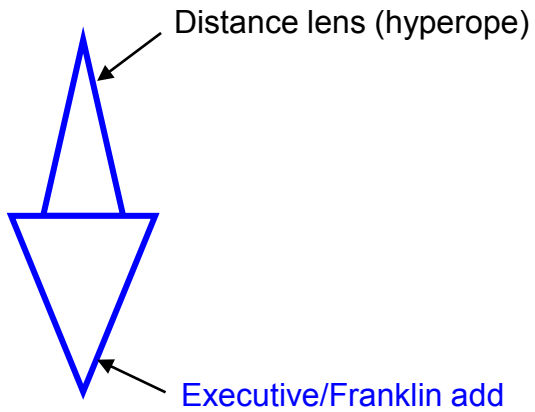


Image Jump



Instead, they are created by **replacing** the entire bottom half of the distance lens with the entire bottom half of an 'add' lens

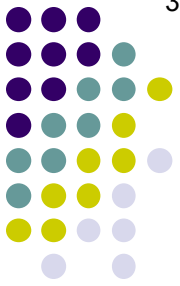
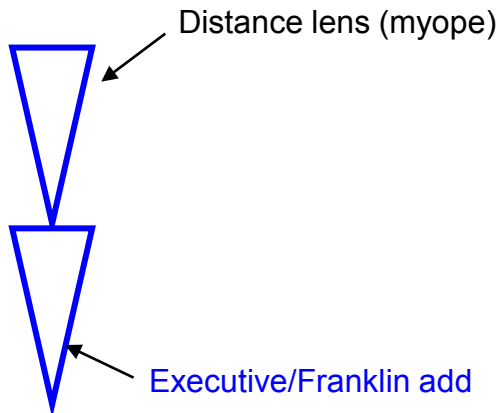
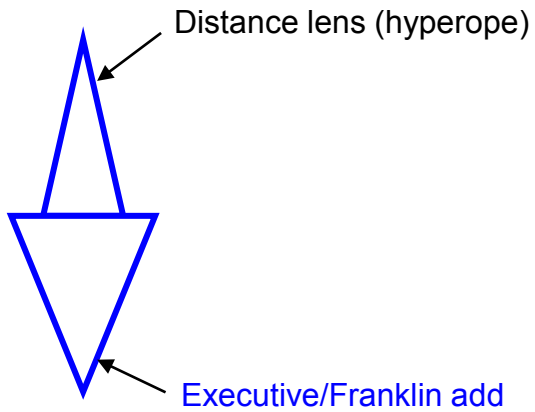


Image Jump



This construction makes Executive/Franklin bifocals recognizable by the line extending across the entire lens

Instead, they are created by **replacing** the entire bottom half of the distance lens with the entire bottom half of an 'add' lens

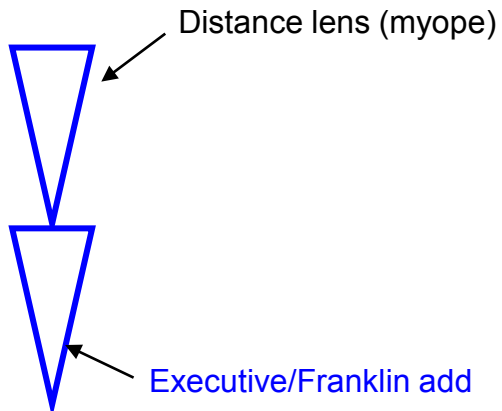
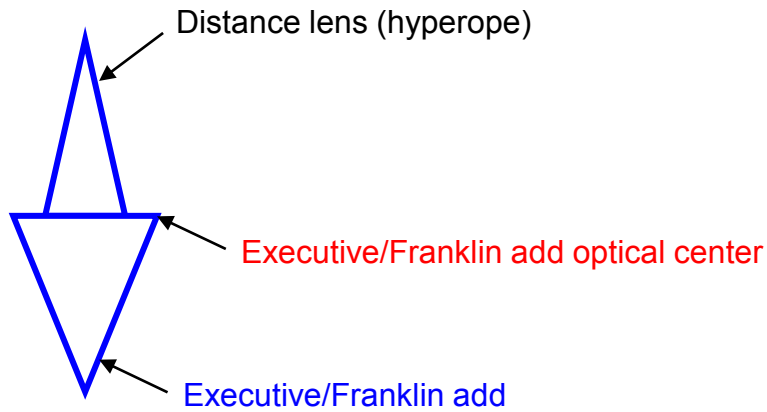


Image Jump



This construction also means the optical center of the add is at the very top of the near segment. Put another way: For the Executive/Franklin bifocal, $h = 0$.

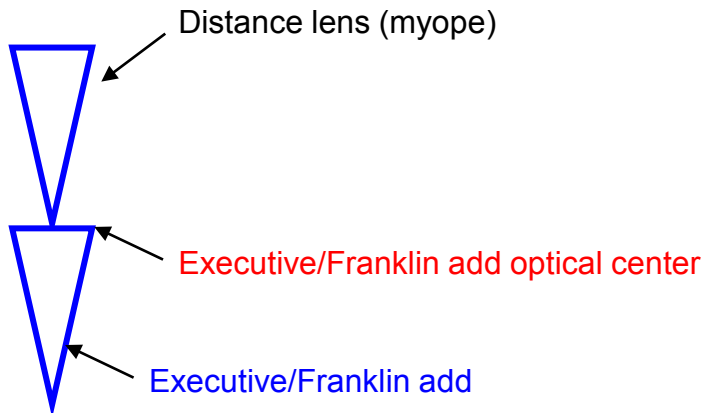
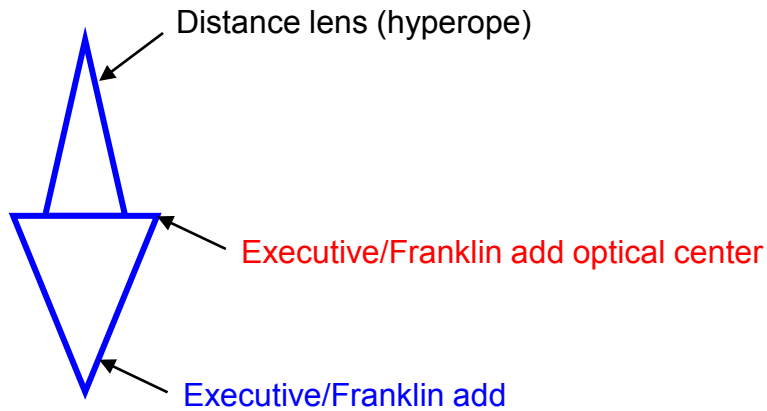


Image Jump



This construction also means the optical center of the add is at the very top of the near segment. Put another way: For the Executive/Franklin bifocal, $h = 0$. And because $h = 0$, hD must also = 0, and thus no prism is induced.

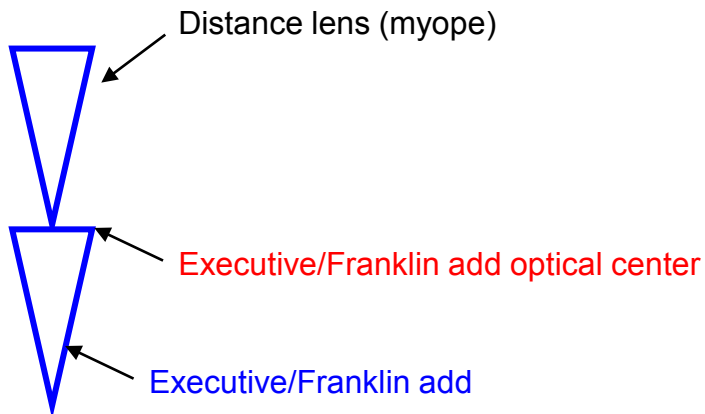
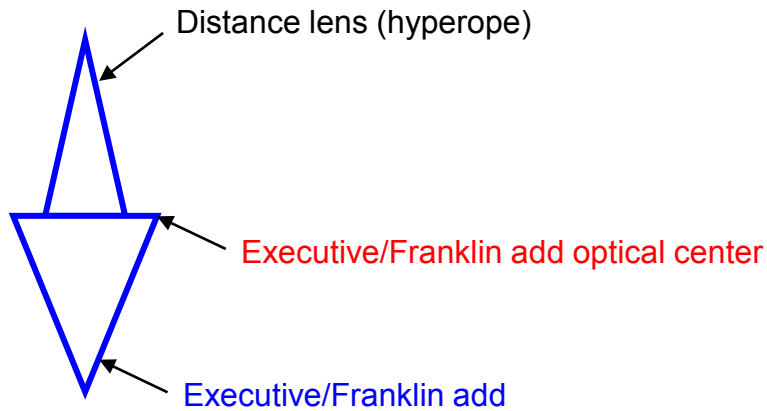
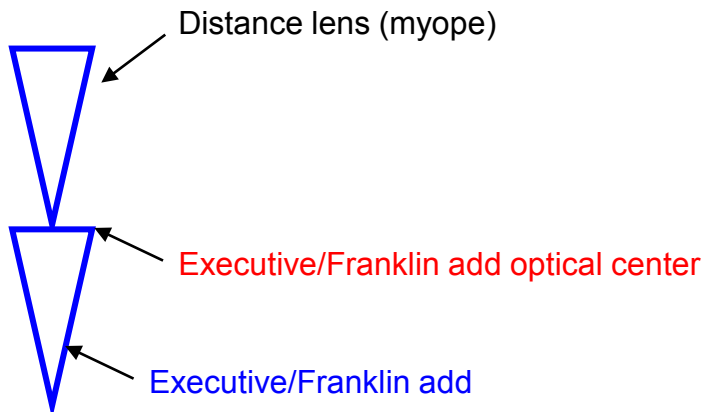


Image Jump



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The takeaway point:
*Executive/Franklin bifocals produce **no** image jump.*



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*

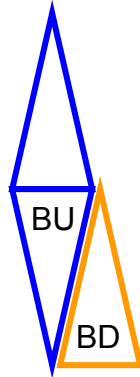


Image Displacement

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

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



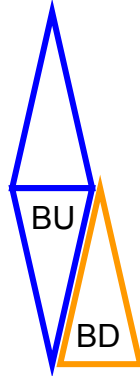
$BU+BD=$ Little net prism \rightarrow
little image displacement

Image Displacement

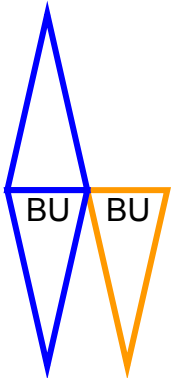
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However, when a **flat-top** segment is placed on a plus lens, note how the prismatic effect is amplified

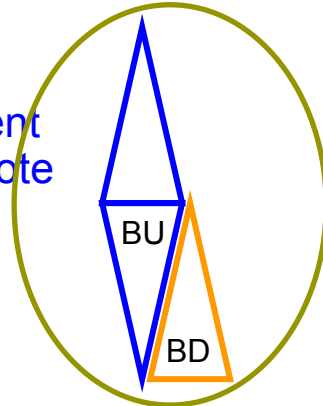
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For a plus lens, image displacement is minimized with a **round-top segment**

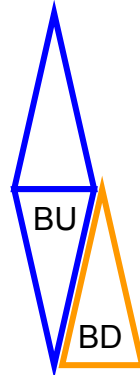


Image Displacement

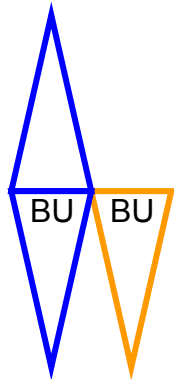
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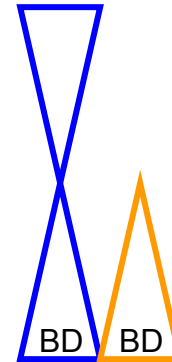
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When a **round-top** segment is placed on a minus lens, note how the prismatic effects amplify one another



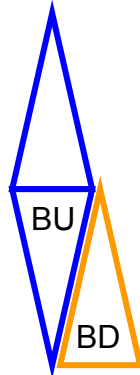
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Image Displacement

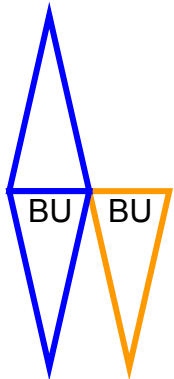
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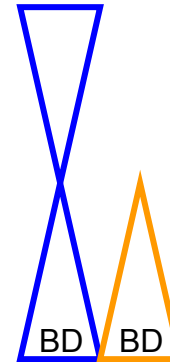
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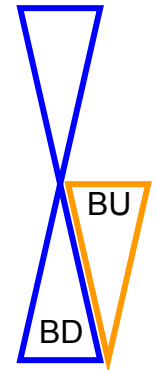
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However, when a **flat-top** segment is placed on a minus lens, the prismatic effects work to cancel one another



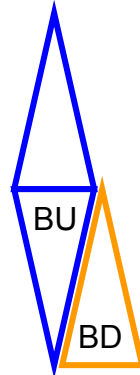
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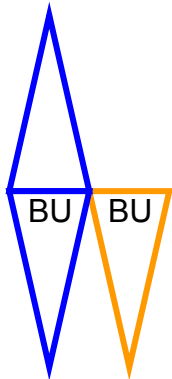
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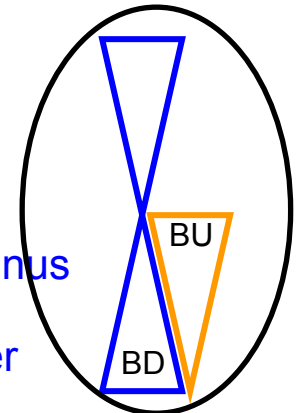
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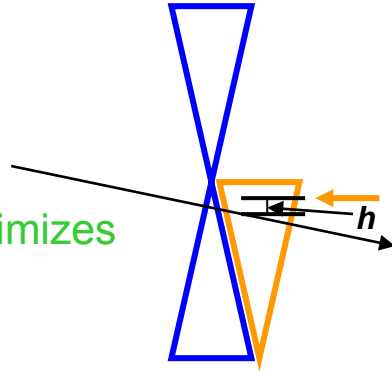
Putting It Together: Which Add Is Best?



Putting It Together: Which Add Is Best?

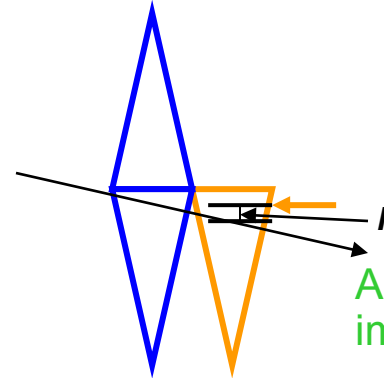


Bifocal adds:
Minus lenses



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

Bifocal adds:
Plus lenses



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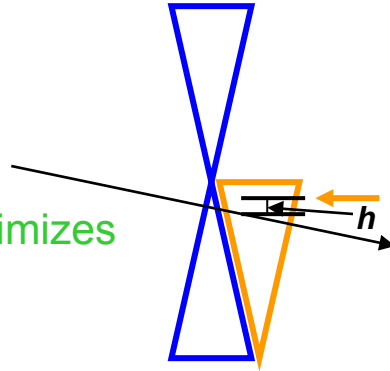
As stated previously, a flat-top segment minimizes image jump for both plus and minus lenses

Putting It Together: Which Add Is Best?

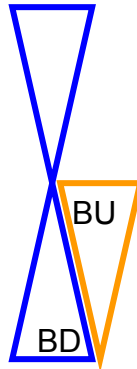


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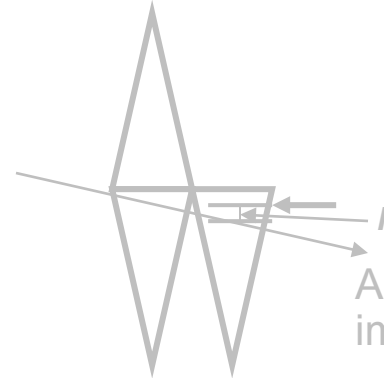
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Putting It Together: Which Add Is Best?

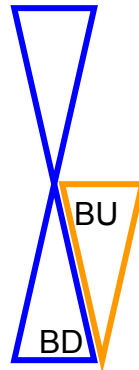
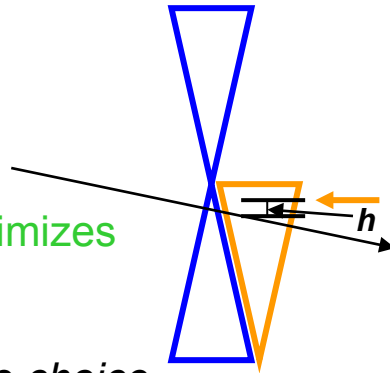


Bifocal adds:
Minus lenses

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

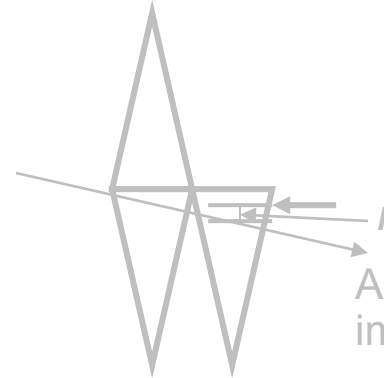
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Putting It Together: Which Add Is Best?

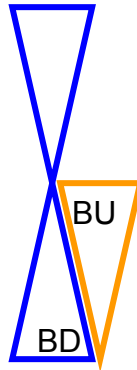
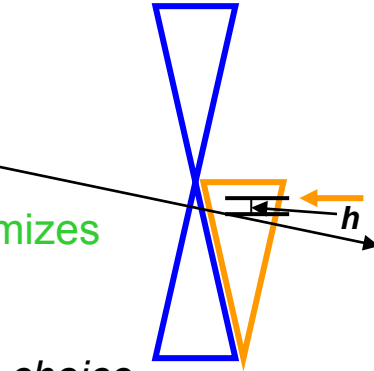


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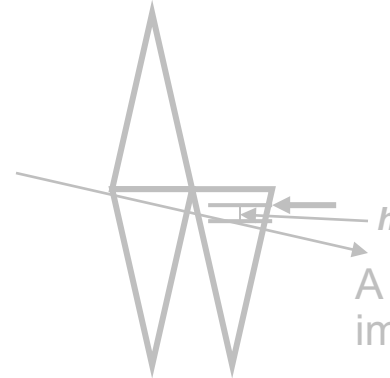
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For a minus lens, always select a flat-top segment



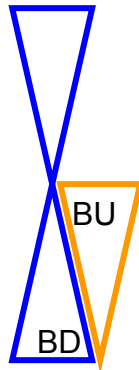
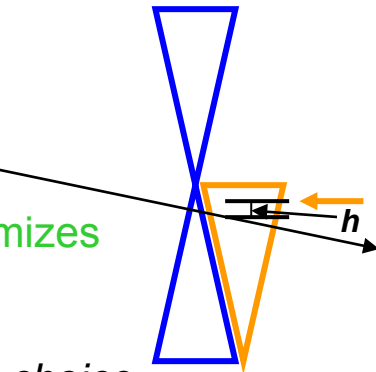
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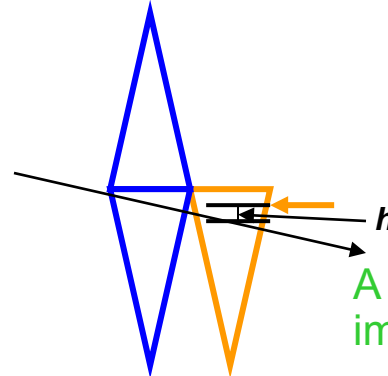
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Bifocal adds:
Plus lenses

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

For plus lenses, the choice is not as easy: A flat-top will minimize jump...





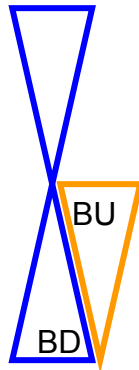
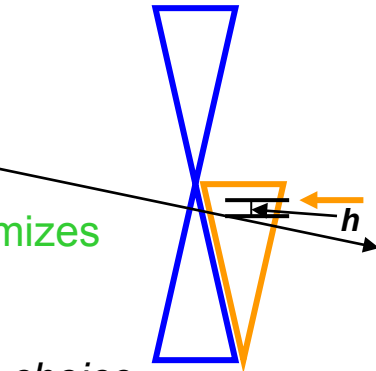
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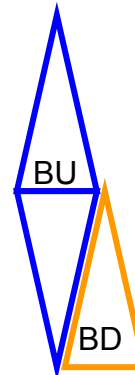
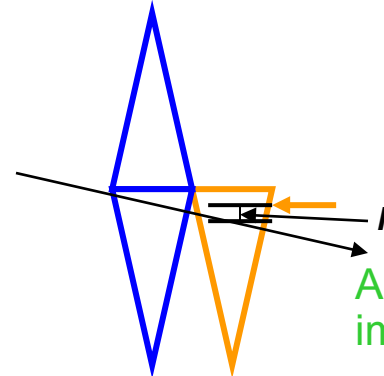
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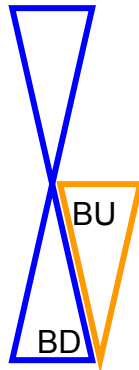
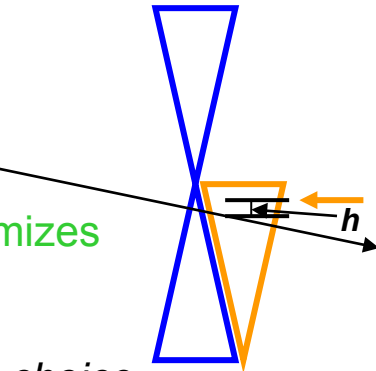
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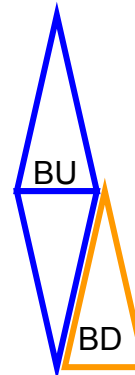
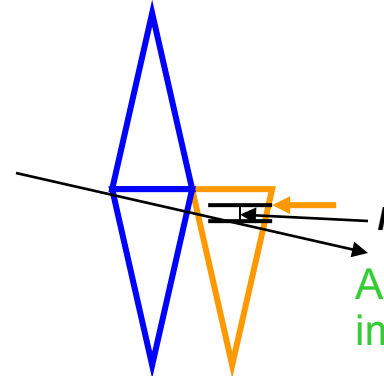
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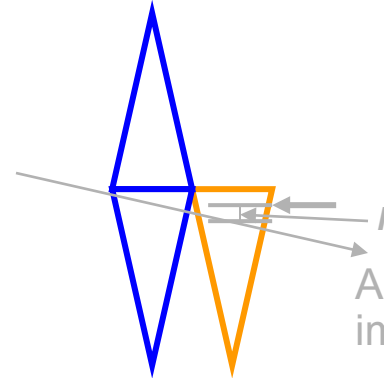
So which is the best add segment for a **plus** lens?

Putting It Together: Which Add Is Best?



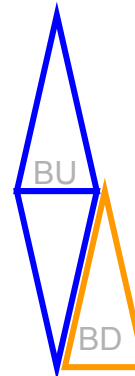
- The choice of segment type for hyperopic adds depends on whether one needs to minimize jump vs displacement

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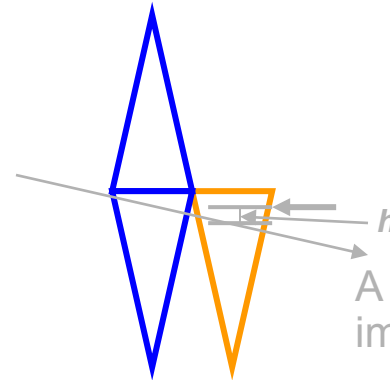
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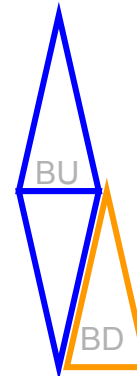
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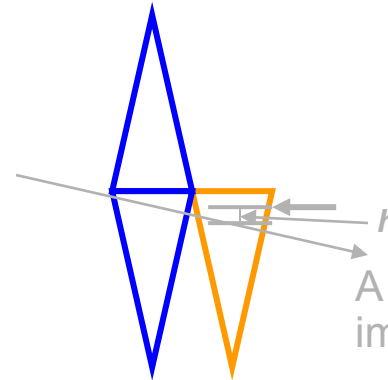
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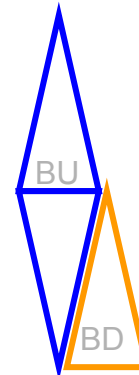
- The choice of segment type for hyperopic adds depends on whether one needs to minimize jump vs displacement
 - *Jump* might bother waiters
 - *Displacement* might bother desk workers
- In practice, most specs are made with flat-top segs
 - Easier and cheaper to make

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