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If all corresponding retinal areas in the two eyes are symmetrically located (i.e., are the same retinal distances and directions from their respective foveas), the two retinas are said to be in normal retinal correspondence (NRC).
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If all corresponding retinal areas in the two eyes are symmetrically located (i.e., are the same retinal distances and directions from their respective foveas), the two retinas are said to be in normal retinal correspondence (NRC).

Likewise, if a symmetrical relationship does not hold, the retinas are said to be in retinal correspondence.
What does it mean to say retinal locations in the two eyes correspond? It means the two locations have the same subjective visual direction.

- If all corresponding retinal areas in the two eyes are symmetrically located (i.e., are the same retinal distances and directions from their respective foveas), the two retinas are said to be in normal retinal correspondence (NRC).
- Likewise, if a symmetrical relationship does not hold, the retinas are said to be in anomalous retinal correspondence (ARC).
With respect to abnormalities of binocular vision: What is the difference between visual confusion and diplopia?
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Confusion occurs when...
With respect to abnormalities of binocular vision: What is the difference between **visual confusion** and **diplopia**?

- **Confusion** occurs when… *different* images are projected onto *corresponding* retinal areas.
With respect to abnormalities of binocular vision: What is the difference between visual confusion and diplopia?

- *Confusion* occurs when... *different* images are projected onto *corresponding* retinal areas.
- Visual confusion produces the visual impression of...
With respect to abnormalities of binocular vision: What is the difference between visual confusion and diplopia?

Confusion occurs when...different images are projected onto corresponding retinal areas.

Visual confusion produces the visual impression of...two objects occupying a single location in visual space.
Visual Confusion

Person perceives two objects as occupying the same location in visual space = Visual confusion

(Eyes esodeviated)
With respect to abnormalities of binocular vision: What is the difference between visual confusion and diplopia?

- Confusion occurs when... different images are projected onto corresponding retinal areas
- Visual confusion produces the visual impression of... two objects occupying a single location in visual space

- Diplopia occurs when...
With respect to abnormalities of binocular vision: What is the difference between visual confusion and diplopia?

Confusion occurs when...different images are projected onto corresponding retinal areas.

Visual confusion produces the visual impression of...two objects occupying a single location in visual space.

Diplopia occurs when...a single image is projected onto noncorresponding retinal areas.
With respect to abnormalities of binocular vision: What is the difference between visual confusion and diplopia?

- **Confusion** occurs when…**different** images are projected onto **corresponding** retinal areas
  - Visual confusion produces the visual impression of…**two** objects occupying a **single** location in visual space

- **Diplopia** occurs when…**a single** image is projected onto **noncorresponding** retinal areas
  - Diplopia produces the visual impression of…
With respect to abnormalities of binocular vision: What is the difference between visual confusion and diplopia?

- **Confusion** occurs when…*different* images are projected onto *corresponding* retinal areas
  - Visual confusion produces the visual impression of…*two* objects occupying a *single* location in visual space

- **Diplopia** occurs when…*a single* image is projected onto *noncorresponding* retinal areas
  - Diplopia produces the visual impression of…*a single* object occupying *two* locations in visual space
Person perceives a single object as occupying two locations in visual space = **Diplopia**

(Eyes esodeviated)
What are the three sensory adaptations the visual system employs to avoid confusion and diplopia?

Mnemonic forthcoming…
What are the three sensory adaptations the visual system employs to avoid confusion and diplopia?

- S
- A
- M

Mnemonic forthcoming…now
What are the three sensory adaptations the visual system employs to avoid confusion and diplopia?

- Suppression
- Anomalous retinal correspondence (ARC)
- Monofixation syndrome

Each is addressed in detail below!
Sensory adaptations: *Suppression*

In a nutshell, suppression is...
● Sensory adaptations: *Suppression*

● In a nutshell, suppression is... *prevention of an image in one eye from reaching conscious awareness*
Sensory adaptations: *Suppression*

In a nutshell, suppression is the prevention of an image in one eye from reaching conscious awareness.

There are two types: [central] and [peripheral].
A

- Sensory adaptations: **Suppression**
- In a nutshell, suppression is... *prevention of an image in one eye from reaching conscious awareness*
- There are two types: **Central** and **peripheral**
Sensory adaptations: *Suppression*

- In a nutshell, suppression is...prevention of an image in one eye from reaching conscious awareness

- There are two types: **Central** and **peripheral**
  - *Central* suppression: prevents conscious awareness of the *foveal* image in the *deviating* eye vs *nonfoveal* image in the *nondeviating* eye
Sensory adaptations: Suppression

In a nutshell, suppression is...prevention of an image in one eye from reaching conscious awareness.

There are two types: Central and peripheral.

- Central suppression: prevents conscious awareness of the foveal image in the deviating eye.
Sensory adaptations: *Suppression*

In a nutshell, suppression is... *prevention of an image in one eye from reaching conscious awareness.*

There are two types: *Central* and *peripheral*.

- **Central suppression**: prevents conscious awareness of the *foveal* image in the *deviating* eye.
- Prevents abnormal visual experience.
Sensory adaptations: Suppression

In a nutshell, suppression is... prevention of an image in one eye from reaching conscious awareness.

There are two types: Central and peripheral.

- **Central** suppression: prevents conscious awareness of the foveal image in the deviating eye.
- Prevents visual confusion.
Sensory adaptations: Suppression

In a nutshell, suppression is... prevention of an image in one eye from reaching conscious awareness.

There are two types: **Central** and **peripheral**

- **Central** suppression: prevents conscious awareness of the *foveal* image in the *deviating* eye

  - Prevents visual confusion

  - Occurs in adult-onset strabismus (or if you cross your eyes); therefore, is considered *(aka physiologic)* suppression
Sensory adaptations: Suppression

In a nutshell, suppression is...prevention of an image in one eye from reaching conscious awareness.

There are two types: **Central** and **peripheral**

- **Central** suppression: prevents conscious awareness of the *foveal* image in the *deviating* eye
  - Prevents visual confusion
  - Occurs in adult-onset strabismus (or if you cross your eyes); therefore, is considered *normal* (aka *physiologic*) suppression
Central Suppression

Image from the nonfixating fovea is suppressed (prevented from reaching conscious awareness)

(Eyes intentionally crossed and therefore esodeviated in person with normal binocularity)
Central Suppression

Central suppression prevents simultaneous awareness of two disparate foveal images, thereby preventing visual confusion.

Image from the nonfixating fovea is suppressed (prevented from reaching conscious awareness).

(Eyes intentionally crossed and therefore esodeviated in person with normal binocularity)
Sensory adaptations: **Suppression**

In a nutshell, suppression is...prevention of an image in one eye from reaching conscious awareness.

There are two types: **Central** and **peripheral**

- **Peripheral suppression**: Prevents conscious awareness of the nonfoveal image in the deviating eye that corresponds to the foveal image in the fixating eye.

Can be facultative (suppression active only when the eye is deviated) or obligatory (suppression active at all times).
Sensory adaptations: **Suppression**

In a nutshell, suppression is...prevention of an image in one eye from reaching conscious awareness.

There are two types: **Central** and **peripheral**

- **Peripheral suppression**: Prevents conscious awareness of the nonfoveal image in the deviating eye that corresponds to the foveal image in the fixating eye.

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Sensory adaptations: Suppression

In a nutshell, suppression is...prevention of an image in one eye from reaching conscious awareness.

There are two types: Central and peripheral.

Peripheral suppression: Prevents conscious awareness of the nonfoveal image in the deviating eye that corresponds to the foveal image in the fixating eye.

Prevents diplopia.

Only develops in immature visual system; therefore, is considered pathologic suppression. Explains why people with childhood strabismus do not experience diplopia, but those with adult-onset do, and why normals do when they cross their eyes (cannot suppress this peripheral area).

Can be facultative (suppression active only when the eye is deviated) or obligatory (suppression active at all times).
Sensory adaptations: Suppression

In a nutshell, suppression is...prevention of an image in one eye from reaching conscious awareness

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Peripheral suppression: Prevents conscious awareness of the nonfoveal image in the deviating eye that corresponds to the foveal image in the fixating eye

Prevents diplopia
Sensory adaptations: **Suppression**

In a nutshell, suppression is...prevention of an image in one eye from reaching conscious awareness.

There are two types: **Central** and **peripheral**

- **Peripheral suppression**: Prevents conscious awareness of the *nonfoveal* image in the *deviating* eye that corresponds to the foveal image in the *fixating* eye.
  - Prevents *diplopia*.
  - Only develops in immature visual system; therefore, is considered *pathologic* suppression.

*Hint: not physiologic*
Sensory adaptations: *Suppression*

In a nutshell, suppression is...prevention of an image in one eye from reaching conscious awareness.

There are two types: **Central** and **Peripheral**

- **Peripheral suppression**: Prevents conscious awareness of the *nonfoveal* image in the *deviating* eye that corresponds to the foveal image in the *fixating* eye.
  - Prevents diplopia
  - Only develops in immature visual system; therefore, is considered *pathologic* suppression.
● **Sensory adaptations: Suppression**

● In a nutshell, suppression is...prevention of an image in one eye from reaching conscious awareness

● There are two types: **Central** and **peripheral**

  ● **Peripheral suppression**: Prevents conscious awareness of the nonfoveal image in the deviating eye that corresponds to the foveal image in the fixating eye
    - Prevents diplopia
    - Only develops in immature visual system; therefore, is considered **pathologic** suppression
      - Explains why people with childhood strabismus do not experience diplopia, but those with adult-onset do, and why normals do when they cross their eyes (cannot suppress this peripheral area)
Sensory adaptations: Suppression

In a nutshell, suppression is...prevention of an image in one eye from reaching conscious awareness

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Peripheral suppression: Prevents conscious awareness of the nonfoveal image in the deviating eye that corresponds to the foveal image in the fixating eye

- Prevents diplopia
- Only develops in immature visual system; therefore, is considered pathologic suppression
  - Explains why people with childhood strabismus do not experience diplopia, but those with adult-onset do, and why normals do when they cross their eyes (cannot suppress this peripheral area)

- Can be facultative (suppression active only when the eye is deviated) or constant (suppression active at all times)
A

- Sensory adaptations: *Suppression*

- In a nutshell, suppression is...prevention of an image in one eye from reaching conscious awareness

- There are two types: *Central* and *peripheral*
  - *Peripheral suppression*: Prevents conscious awareness of the *nonfoveal* image in the *deviating* eye that corresponds to the foveal image in the *fixating* eye
    - Prevents *diplopia*
    - Only develops in immature visual system; therefore, is considered *pathologic* suppression
      - Explains why people with childhood strabismus do not experience diplopia, but those with adult-onset do, and why normals do when they cross their eyes (cannot suppress this peripheral area)
    - Can be *facultative* (suppression active only when the eye is deviated) or *constant* (suppression active at all times)
A peripheral retinal location has temporarily acquired a common visual direction with the fixating fovea. The image from this location cannot be suppressed and therefore does reach conscious awareness, producing a visual experience of the same object being located at two points in visual space simultaneously (i.e., a visual experience of diplopia).
However, in a person with a history of childhood strabismus, **peripheral suppression** prevents conscious awareness of the image from the deviated retina.
Sensory adaptations: Suppression

In a nutshell, suppression is the prevention of an image in one eye from reaching conscious awareness. There are two types: Central and peripheral.

Peripheral suppression: Prevents conscious awareness of the nonfoveal image in the deviating eye that corresponds to the foveal image in the fixating eye. Prevents diplopia. Only develops in immature visual system; therefore, is considered pathologic suppression. Explains why people with childhood strabismus do not experience diplopia, but those with adult-onset do, and why normals do when they cross their eyes (cannot suppress this peripheral area).

Can be facultative (suppression active only when the eye is deviated) or obligatory (suppression active at all times).

Visualizing Suppression

Think about what you see when you cross your eyes. (In fact, go ahead and try it—look at something across the room, then cross your eyes.) The image of regard immediately becomes doubled (and blurred from induced accommodation, but that’s a topic for another day). But note what you don’t see—whatever image is falling on the fovea of your nonfixating eye. The fovea of your nonfixating eye must be pointing at something; so why don’t you see it?

You don’t see it because this foveal image is prevented from reaching consciousness by the sensory adaptation of central suppression. What would you see without central suppression? You would see the two foveal images-of-regard seeming to occupy the same location in visual space—the definition of visual confusion. You would see two objects in one location. But you don’t, thanks to central suppression.

On the other hand, the image of regard in the fixating eye is also falling on a peripheral retinal area in your nonfixating eye, and suppression of this image (peripheral suppression) is a sensory adaptation available only on an acquired basis in an immature visual system—it can’t be ‘conjured up on the fly’ during volitional eye-crossing. The result is that crossing one’s eyes produces diplopia—one object seen in two locations—but (thanks to central suppression) not visual confusion.
Sensory adaptations: Anomalous retinal correspondence (ARC)

ARC occurs when an area of the deviating eye acquires a visual direction with the fovea of the fixating eye.
Sensory adaptations: *Anomalous retinal correspondence* (ARC)

ARC occurs when a peripheral area of the deviating eye acquires a common visual direction with the fovea of the fixating eye.
Sensory adaptations: *Anomalous retinal correspondence (ARC)*

- ARC occurs when a *peripheral* area of the deviating eye acquires a *common visual direction* with the *fovea* of the fixating eye.
- Restores some sense of two words.
● Sensory adaptations: *Anomalous retinal correspondence* (ARC)
  ● ARC occurs when a peripheral area of the deviating eye acquires a common visual direction with the fovea of the fixating eye
  ● Restores some sense of binocular cooperation
In a person with a history of childhood strabismus, ARC often develops, facilitating binocular coordination by allowing fusion.
Monofixators have peripheral fusion but no central fusion
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Sensory adaptations: **Monofixation syndrome:** True/False
Sensory adaptations: **Monofixation syndrome:** True/False

- Monofixators have peripheral fusion but no central fusion  \( T \)
- A small foveal suppression scotomata is present OU
Sensory adaptations: **Monofixation syndrome:** True/False

- Monofixators have peripheral fusion but no central fusion **T**
- A small foveal suppression scotomata is present **F**
- Muscle balance is typically a micro (<8 PD) **T**
- Amblyopia is uncommon **F**
- Is an indication for re-op if it develops after **T**
- Can be diagnosed via the **F**
  - Worth 4-dot testing reveals 4 dots at distance and 2 or 3 at near **F**
  - Stereopsis in the 200-3000 arc-s range is usually not achievable **F**
Sensory adaptations: **Monofixation syndrome**: True/False

- Monofixators have peripheral fusion but no central fusion
- A small foveal suppression scotomata is present OU
- Retinal correspondence = Small angle ARC

Sensory adaptations:

- Monofixation syndrome: True/False
- Retinal correspondence = Small angle ARC
Sensory adaptations: **Monofixation syndrome**: True/False

- Monofixators have peripheral fusion but no central fusion
- A small foveal suppression scotomata is present OU
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**Worth 4-dot testing reveals 4 dots at distance and 2 or 3 at near**

Stereopsis in the 200-3000 arc-s range is usually not achievable
Sensory adaptations: **Monofixation syndrome**: True/False

- Monofixators have peripheral fusion but no central fusion
- A small foveal suppression scotomata is present OU
- Retinal correspondence = Small angle ARC
- Muscle balance is typically a micro (<8 PD) XT
Sensory adaptations: **Monofixation syndrome:** True/False

- Monofixators have peripheral fusion but no central fusion
- A small foveal suppression scotomata is present OU
- Retinal correspondence = Small angle ARC
- Muscle balance is typically a micro (<8 PD)
Sensory adaptations: **Monofixation syndrome:** True/False

- Monofixators have peripheral fusion but no central fusion \( T \) unilaterally
- A small foveal suppression scotomata is present OU \( ^\top \)
- Retinal correspondence = Small angle ARC \( T_{ET} \)
- Muscle balance is typically a micro (<8 PD) \( \times T \)
- Amblyopia is uncommon
Sensory adaptations: **Monofixation syndrome:** True/False

- Monofixators have peripheral fusion but no central fusion
- A small foveal suppression scotomata is present OU
- Retinal correspondence = Small angle ARC
- Muscle balance is typically a micro (<8 PD)
- Amblyopia is uncommon
Sensory adaptations: **Monofixation syndrome:** True/False

- Monofixators have peripheral fusion but no central fusion
- A small foveal suppression scotomata is present OU
- Retinal correspondence = Small angle ARC
- Muscle balance is typically a micro (<8 PD)
- Amblyopia is uncommon
- Is an indication for re-op if it develops after ET surgery
Sensory adaptations: Monofixation syndrome: True/False

- Monofixators have peripheral fusion but no central fusion \( \text{T} \) unilaterally
- A small foveal suppression scotomata is present OU \( \text{F} \)
- Retinal correspondence = Small angle ARC \( \text{T}_{\text{ET}} \)
- Muscle balance is typically a micro (<8 PD) \( \text{XT} \)
- Amblyopia is uncommon \( \text{F} \)
- Is an indication for re-op if it develops after ET surgery \( \text{F} \)
Sensory adaptations: **Monofixation syndrome: True/False**

- Monofixators have peripheral fusion but no central fusion **T**
- A small foveal suppression scotomata is present OU **F**
- Retinal correspondence = Small angle ARC **T**
- Muscle balance is typically a micro (<8 PD) **F**
- Amblyopia is uncommon **F**
- Is an indication for re-op if it develops after ET surgery **F**
- Can be diagnosed via the $4\Delta BO$ prism test **F**
Sensory adaptations: **Monofixation syndrome:** True/False

- Monofixators have peripheral fusion but no central fusion **T**
- A small foveal suppression scotomata is present OU **F**
- Retinal correspondence = Small angle ARC **T**
- Muscle balance is typically a micro (<8 PD) **F**
- Amblyopia is uncommon **F**
- Is an indication for re-op if it develops after ET surgery **F**
- Can be diagnosed via the $4\Delta BO$ prism test **T**
Sensory adaptations: **Monofixation syndrome: True/False**

- Monofixators have peripheral fusion but no central fusion **T**
- A small foveal suppression scotomata is present **F**
- Retinal correspondence = Small angle ARC **T**
- Muscle balance is typically a micro (<8 PD) **F**
- Amblyopia is uncommon **F**
- Is an indication for re-op if it develops after ET surgery **F**
- Can be diagnosed via the $4\Delta BO$ prism test **T**
- **Worth 4-dot** testing reveals 4 dots at distance and 2 or 3 at near**
Sensory adaptations: *Monofixation syndrome*: True/False

- Monofixators have peripheral fusion but no central fusion: **True**
- A small foveal suppression scotomata is present OU: **False**
- Retinal correspondence = Small angle ARC: **True**
- Muscle balance is typically a micro (<8 PD): **False**
- Amblyopia is uncommon: **False**
- Is an indication for re-op if it develops after ET surgery: **False**
- Can be diagnosed via the $4\Delta BO$ prism test: **False**
- *Worth 4-dot* testing reveals 4 dots at distance and 2 or 3 at near: **False**
Monofixators have peripheral fusion but no central fusion
A small foveal suppression scotomata is present OU
Retinal correspondence = Small angle ARC
Muscle balance is typically a micro (<8 PD)
Amblyopia is uncommon
Is an indication for re-op if it develops after ET surgery
Can be diagnosed via the $4\Delta BO$ prism test
Worth 4-dot testing reveals 4 dots at distance and 2 or 3 at near
Stereopsis in the 200-3000 arc-s range is usually not achievable

Sensory adaptations: **Monofixation syndrome:** True/False
Monofixators have peripheral fusion but no central fusion.

- A small foveal suppression scotomata is present OU.
- Retinal correspondence = Small angle ARC.
- Muscle balance is typically a micro (<8 PD).
- Amblyopia is uncommon.
- Is an indication for re-op if it develops after ET surgery.
- Can be diagnosed via the 4△ BO prism test.
- Worth 4-dot testing reveals 4 dots at distance and 2 or 3 at near.
- Stereopsis in the 200-3000 arc-s range is usually not achievable.
Monofixation syndrome is a common entity. These patients have peripheral fusion without central fusion; thus they possess gross stereopsis (200-3000 arc-s) but not the high-grade stereopsis that requires bifoveation (~40 arc-s). This is because they cannot bifixate an object of regard (hence the term ‘monofixation’). Vision in the nonfixating eye is characterized by a small foveal suppression scotoma and minute ARC. Muscle balance testing usually reveals an ET of about 8PD. Amblyopia is the rule; it is usually mild but can be profound. Monofixation is considered a desirable outcome in correction of ET with spectacles or surgery. The 4° BO prism test is very useful in diagnosing a monofixation syndrome (review the excellent description of this test available in the Peds BCSC book). Worth 4-dot testing reveals a characteristic pattern: When assessed at a distance of 2 feet, the lights fall outside the suppression scotoma and the patient perceives all four dots. However, when the light is held at distance (10+ feet), the lights fall within the suppression scotoma, and only 2 or 3 dots will be appreciated with the non-suppressing eye.
What is the name of this plane in visual space?
Empirical Horopter
**Empirical Horopter** (or ‘Veith–Müller circle’)

Would also accept the answer *Vieth-Müller circle* here (although there are technical distinctions between the two)
What is the definition of the empirical horopter?
Q/A

Empirical Horopter

= the set of points in visual space that stimulate

three words

Fixation point

Point A in visual space

Point B in visual space
Empirical Horopter

= the set of points in visual space that stimulate corresponding retinal areas
The location of the horopter changes as a function of fixation. 

Point $\text{A}$ in visual space and Point $\text{B}$ in visual space are connected by lines to the fixation point, illustrating the concept of the Empirical Horopter.

**Empirical Horopter**

$= \text{the set of points in visual space that stimulate corresponding retinal areas}$

The location of the horopter changes as a function of fixation.
The location of the horopter changes as a function of fixation.

**Empirical Horopter**

= the set of points in visual space that stimulate corresponding retinal areas

The location of the horopter changes as a function of fixation.
Empirical Horopter

= the set of points in visual space that stimulate corresponding retinal areas

The location of the horopter changes as a function of fixation

If the a pair and b pair are each equidistant from their foveas, the retinas are said to be in NRC.

Abb. = the set of points in visual space that stimulate corresponding retinal areas.
Empirical Horopter

= the set of points in visual space that stimulate corresponding retinal areas

The location of the horopter changes as a function of fixation.

If the \( a \) pair and \( b \) pair are each equidistant from their foveas, the retinas are said to be in NRC.
Empirical HoRopter

What is the clinical significance of the horopter?

If the \( a \) pair and \( b \) pair are each equidistant from their foveas, the retinas are said to be in NRC.
Empirical Horopter

What is the clinical significance of the horopter?
The significance of the horopter derives from its relationship to the area surrounding it. Speaking of:

If the $a$ pair and $b$ pair are each equidistant from their foveas, the retinas are said to be in NRC.
What is the eponymous name of the area shaded yellow?
What is the eponymous name of the area shaded yellow?
What is the eponymous name of the area shaded yellow?

Panum’s Area

Panum’s Area

Empirical Horopter

What is the significance of Panum’s area?

Points in visual space outside of Panum’s area will produce a visual experience of diplopia.
What is the eponymous name of the area shaded yellow?

Empirical Horopter

What is the significance of Panum’s area?
By definition, any point in visual space not on the empirical horopter will stimulate noncorresponding retinal locations, and therefore should give rise to diplopia.
What is the eponymous name of the area shaded yellow?

What is the significance of Panum's area?
By definition, any point in visual space not on the empirical horopter will stimulate noncorresponding retinal locations, and therefore should give rise to diplopia. However, there is a set of points 'around' the horopter for which the slight retinal noncorrespondence stimulates not diplopia, but rather an impression of three-dimensionality--that is, stereopsis.
What is the eponymous name of the area shaded yellow?

What is the significance of Panum’s area?
By definition, any point in visual space not on the empirical horopter will stimulate noncorresponding retinal locations, and therefore should give rise to diplopia. However, there is a set of points ‘around’ the horopter for which the slight retinal noncorrespondence stimulates not diplopia, but rather an impression of three-dimensionality--that is, stereopsis. This space around the horopter is called **Panum’s area**.
What is the significance of Panum’s area?
By definition, any point in visual space not on the empirical horopter will stimulate non-corresponding retinal locations, and therefore should give rise to diplopia. However, there is a set of points ‘around’ the horopter for which the slight retinal noncorrespondence stimulates not diplopia, but rather an impression of three-dimensionality—that is, stereopsis. This space around the horopter is called Panum’s area. (Points in visual space outside of Panum’s area will produce the visual experience of diplopia.)

What is the eponymous name of the area shaded yellow?