Before you begin: This is a big topic, and big topics beget big slide-sets. There are natural breaks around slides 90 and 254; I placed a *break time!* slide at those points to mark them.
Horner Syndrome

- **Cause:** *Sympathetic dysfunction*
- **Triad:**
  - Ptosis
  - Miosis
  - Anhidrosis
Horner Syndrome

- **Cause:** *Sympathetic dysfunction*
- **Triad:**
  - Ptosis
  - Miosis
  - Anhidrosis
Horner Syndrome

- **Cause:** *Sympathetic dysfunction*
- **Triad:**
  - **Ptosis**

*What does the term ‘ptosis’ mean in this context?*

- Both

With regard to each lid, how is it (mal)positioned in ptosis 2ndry to Horner's?

- The upper lid is too... low
- The lower lid is too... high
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

*What does the term ‘ptosis’ mean in this context?*
It describes an abnormal and unintended narrowing of the interpalpebral fissure
What does the term ‘ptosis’ mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this ‘abnormal narrowing’ involve the upper lid, the lower lid, or both?
Horner Syndrome

- Cause: Sympathetic dysfunction
- Triad:
  - Ptosis

What does the term ‘ptosis’ mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this ‘abnormal narrowing’ involve the upper lid, the lower lid, or both?
Both
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

**What does the term ‘ptosis’ mean in this context?**
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

**In Horner syndrome, does this ‘abnormal narrowing’ involve the upper lid, the lower lid, or both?**
Both.

**With regard to each lid, how is it (mal)positioned in ptosis 2ndry to Horners?**
The upper lid is too...
The lower lid is too...
Horner Syndrome

- **Cause: Sympathetic dysfunction**
- **Triad:**
  - **Ptosis**

*What does the term ‘ptosis’ mean in this context?*
It describes an abnormal and unintended narrowing of the interpalpebral fissure

*In Horner syndrome, does this ‘abnormal narrowing’ involve the upper lid, the lower lid, or both?*
Both

*With regard to each lid, how is it (mal)positioned in ptosis 2ndry to Horners?*
The upper lid is too...low
The lower lid is too...
Horner Syndrome

- **Cause:** *Sympathetic dysfunction*
- **Triad:**
  - **Ptosis**

**What does the term ‘ptosis’ mean in this context?**
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

**In Horner syndrome, does this ‘abnormal narrowing’ involve the upper lid, the lower lid, or both?**
Both

**With regard to each lid, how is it (mal)positioned in ptosis 2ndry to Horners?**
The upper lid is too...low
The lower lid is too...
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - Anhidrosis

**What does the term ‘ptosis’ mean in this context?**
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

**In Horner syndrome, does this ‘abnormal narrowing’ involve the upper lid, the lower lid, or both?**
Both

**With regard to each lid, how is it (mal)positioned in ptosis 2ndry to Horners?**
- The upper lid is too...low
- The lower lid is too...high
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What does the term ‘ptosis’ mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this ‘abnormal narrowing’ involve the upper lid, the lower lid, or both?
Both

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner’s?
The upper lid is too... low.
The lower lid is too... high.

Note: Some authors refer to this malpositioning of the LL as ‘reverse ptosis;’ however, to the best of my ability to ascertain, this term does not appear in any BCSC book.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis

What muscle is most influential in terms of positioning the upper lid?

What nerve innervates the levator?

Is levator dysfunction implicated in the ptosis associated with Horner's?

What does the term 'ptosis' mean in this context?

It describes an abnormal and unintended narrowing of the interpalpebral fissure in Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?

Both

With regard to each lid, how is it (mal)positioned in ptosis due to Horner's?

The upper lid is too...low

The lower lid is too...high
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - *Ptosis*

*What muscle is most influential in terms of positioning the upper lid?*

The levator palpebrae superioris

*What muscle is most influential in terms of positioning the lower lid?*

No

*What does the term 'ptosis' mean in this context?*

It describes an abnormal and unintended narrowing of the interpalpebral fissure.

*In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?*

Both

*With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?*

- **The upper lid is too...low**
- **The lower lid is too...high**
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What does the term 'ptosis' mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?
Both

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horners?
The upper lid is too...low
The lower lid is too...high

What muscle is most influential in terms of positioning the upper lid?
The levator palpebrae superioris

What nerve innervates the levator?
CN3

Is levator dysfunction implicated in the ptosis associated with Horners?
No
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What does the term 'ptosis' mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?
Both.

With regard to each lid, how is it (mal)positioned in ptosis due to Horner's?
The upper lid is too...low
The lower lid is too...high

What muscle is most influential in terms of positioning the upper lid?
The levator palpebrae superioris.

What nerve innervates the levator?
CN3.
Horner Syndrome

- **Cause:** Sympathetic dysfunction

- **Triad:**
  - **Ptosis**

  What muscle is most influential in terms of positioning the upper lid?
  The levator palpebrae superioris

  What nerve innervates the levator?
  CN3

  Is levator dysfunction implicated in the ptosis associated with Horner's?
  No

  In regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?
  The upper lid is too...low
  The lower lid is too...high
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What does the term 'ptosis' mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?
Both

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner syndrome?
The upper lid is too...low
The lower lid is too...high

What muscle is most influential in terms of positioning the upper lid?
The levator palpabrae superioris

What nerve innervates the levator?
CN3

Is levator dysfunction implicated in the ptosis associated with Horner syndrome?
No
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What muscle is most influential in terms of positioning the upper lid?
The levator palpebrae superioris

What nerve innervates the levator?
CN3

Is levator dysfunction implicated in the ptosis associated with Horner’s?
No

If not the levator, what named muscle is implicated in the ptosis associated with Horner’s?
Müller’s muscle

Are the fibers in Müller’s muscle striated, or smooth?
Smooth

Where is Müller’s muscle located?
It forms a narrow strip between the distal tendon of the levator and the tarsal plate of the upper lid.

- **Ptosis**
  - In Horner syndrome, does the "abnormal narrowing" involve the upper lid, the lower lid, or both?
    - Both
  - With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner’s?
    - The upper lid is too...low
    - The lower lid is too...high
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - Anhidrosis

**Horner Syndrome**

- **What does the term 'ptosis' mean in this context?**
  - It describes an abnormal and unintended narrowing of the interpalpebral fissure.

- **In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?**
  - Both

- **With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?**
  - The upper lid is too...low
  - The lower lid is too...high

- **What muscle is most influential in terms of positioning the upper lid?**
  - The levator palpebrae superioris

- **What nerve innervates the levator?**
  - CN3

- **Is levator dysfunction implicated in the ptosis associated with Horner's?**
  - No

- **If not the levator, what named muscle is implicated in the ptosis associated with Horner's?**
  - Müller's muscle

- **Are the fibers in Müller’s muscle striated, or smooth?**
  - Smooth

- **Where is Müller’s muscle located?**
  - It forms a narrow strip between the distal tendon of the levator and the tarsal plate of the upper lid.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

*What muscle is most influential in terms of positioning the upper lid?*
The levator palpebrae superioris

*What nerve innervates the levator?*
CN3

*Is levator dysfunction implicated in the ptosis associated with Horner's?*
No

*If not the levator, what named muscle is implicated in the ptosis associated with Horner's?*
Müller’s muscle

*Are the fibers in Müller’s muscle striated, or smooth?*
Smooth
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

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In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?
Both

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?
The upper lid is too...low
The lower lid is too...high

What muscle is most influential in terms of positioning the upper lid?
The levator palpebrae superioris

What nerve innervates the levator?
CN3

Is levator dysfunction implicated in the ptosis associated with Horner's?
No

If not the levator, what named muscle is implicated in the ptosis associated with Horner's?
Müller's muscle

Are the fibers in Müller's muscle striated, or smooth?
Smooth
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
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What does the term 'ptosis' mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?
Both.

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?
The upper lid is too...low.
The lower lid is too...high.

What muscle is most influential in terms of positioning the upper lid?
The levator palpebrae superioris.

What nerve innervates the levator?
CN3.

Is levator dysfunction implicated in the ptosis associated with Horner's?
No.

If not the levator, what named muscle is implicated in the ptosis associated with Horner's?
Müller's muscle.

Are the fibers in Müller's muscle striated, or smooth?
Smooth.

Smooth muscle fibers...What does this imply about the innervation of Müller's muscle?
**Horner Syndrome**

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What does the term 'ptosis' mean in this context?

It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?

Both

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?

- The upper lid is too...low
- The lower lid is too...high

What muscle is most influential in terms of positioning the upper lid?

The levator palpebrae superioris

What nerve innervates the levator?

CN3

Is levator dysfunction implicated in the ptosis associated with Horner's?

No

If not the levator, what named muscle is implicated in the ptosis associated with Horner's?

Müller's muscle

Are the fibers in Müller’s muscle striated, or smooth?

Smooth

Smooth muscle fibers...What does this imply about the innervation of Müller’s muscle?

It implies its innervation is via the ANS (in this case, the sympathetic branch of the ANS).
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

  What does the term 'ptosis' mean in this context?
  It describes an abnormal and unintended narrowing of the interpalpebral fissure.

  In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?
  Both

  With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?
  The upper lid is too...low
  The lower lid is too...high

  What muscle is most influential in terms of positioning the upper lid?
  The levator palpebrae superioris

  What nerve innervates the levator?
  CN3

  Is levator dysfunction implicated in the ptosis associated with Horner's?
  No

  If not the levator, what named muscle is implicated in the ptosis associated with Horner's?
  Müller's muscle

  Are the fibers in Müller's muscle striated, or smooth?
  Smooth

  Smooth muscle fibers...What does this imply about the innervation of Müller's muscle?
  It implies its innervation is via the ANS (in this case, the sympathetic branch of the ANS).
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

**What muscle is most influential in terms of positioning the upper lid?**
The levator palpebrae superioris

**What nerve innervates the levator?**
CN3

Is levator dysfunction implicated in the ptosis associated with Horner's?
No

In regard to each lid, how is it (mal)positioned in ptosis secondary to Horner’s?
- The upper lid is too... low
- The lower lid is too... high

If not the levator, what named muscle is implicated in the ptosis associated with Horner’s?
Müller’s muscle

Are the fibers in Müller’s muscle striated, or smooth?
Smooth

Where is Müller’s muscle located?
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**
Horner Syndrome

Müller’s muscle
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What does the term 'ptosis' mean in this context?

It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?

Both

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?

- The upper lid is too...low
- The lower lid is too...high

What muscle is most influential in terms of positioning the upper lid?

The *levator palpebrae superioris*

If innervation to the levator is lost, how much ptosis results?

Total/complete—the lid is closed

If innervation to Müller's muscle is lost, how much ptosis results?

Not nearly so much—about 2 mm or so

If innervation to the levator is lost, how much ptosis results?

Total/complete—the lid is closed

If innervation to Müller's muscle is lost, how much ptosis results?

Not nearly so much—about 2 mm or so

Is levator dysfunction implicated in the ptosis associated with Horner's?

No

If not the levator, what named muscle is implicated in the ptosis associated with Horner's?

Müller's muscle

Are the fibers in Müller's muscle striated, or smooth?

Smooth

Where is Müller's muscle located?

Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - Anhidrosis

What does the term 'ptosis' mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?
Both

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?
The upper lid is too...low
The lower lid is too...high

What muscle is most influential in terms of positioning the upper lid?
**levator palpebrae superioris**

If innervation to the levator is lost, how much ptosis results?
Total/complete—the lid is closed

Is levator dysfunction implicated in the ptosis associated with Horner's?
No

If not the levator, what named muscle is implicated in the ptosis associated with Horner's?
Müller's muscle

Are the fibers in Müller's muscle striated, or smooth?
Smooth

Where is Müller's muscle located?
Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What muscle is most influential in terms of positioning the upper lid?
- **The levator palpebrae superioris**

If innervation to the levator is lost, how much ptosis results?
- Total/complete—the lid is closed

If innervation to Müller’s muscle is lost, how much ptosis results?
- Not nearly so much—about 2 mm or so

Is levator dysfunction implicated in the ptosis associated with Horner's?
- No

If not the levator, what named muscle is implicated in the ptosis associated with Horner’s?
- Müller’s muscle

Are the fibers in Müller’s muscle striated, or smooth?
- Smooth

Where is Müller’s muscle located?
- Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid

The upper lid is too...low
- The lower lid is too...high
Horner Syndrome

- Cause: Sympathetic dysfunction
- Triad:
  - Ptosis

What muscle is most influential in terms of positioning the upper lid?
The levator palpebrae superioris

If innervation to the levator is lost, how much ptosis results?
Total/complete—the lid is closed

If innervation to Müller’s muscle is lost, how much ptosis results?
Not nearly so much—about 2 mm or so

Are the fibers in Müller’s muscle striated, or smooth?
Smooth

Where is Müller’s muscle located?
Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - Anhidrosis

What does the term 'ptosis' mean in this context?
It describes an abnormal and unintended narrowing of the interpalpebral fissure.

In Horner syndrome, does this 'abnormal narrowing' involve the upper lid, the lower lid, or both?
Both

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?
The upper lid is too...low
The lower lid is too...high

What muscle is most influential in terms of positioning the upper lid?
The **levator palpebrae superioris**

What nerve innervates the levator?
CN3

Is levator dysfunction implicated in the ptosis associated with Horner’s?
No

If not the levator, what named muscle is implicated in the ptosis associated with Horner’s?
Müller’s muscle

Are the fibers in Müller’s muscle striated, or smooth?
Smooth

Where is Müller’s muscle located?
Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid.

If innervation to the levator is lost, how much ptosis results?
Total/complete—the lid is closed

If innervation to Müller’s muscle is lost, how much ptosis results?
Not nearly so much—about 2 mm or so
Horner Syndrome

Horner’s ptosis in adult

Horner’s ptosis in infant

Horner syndrome: Ptosis
Horner Syndrome

Horner’s ptosis in adult

Not Horner’s ptosis in child (ptoo ptotic)

Horner’s ptosis in infant

Not Horner’s ptosis in adult (ptoo ptotic)

Horner syndrome: Ptosis
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What muscle is most influential in terms of positioning the upper lid?
The levator palpebrae superioris

What nerve innervates the levator? CN3

Is levator dysfunction implicated in the ptosis associated with Horner’s?
No

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner’s?
The upper lid is too...low

The lower lid is too...high

Is Müller’s muscle implicated in the Horner-related ptosis of the lower lid?
If not the levator, what named muscle is implicated in the ptosis associated with Horner’s?
Müller’s muscle

Are the fibers in Müller’s muscle striated, or smooth?
Smooth

Where is Müller’s muscle located?
Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

What muscle is most influential in terms of positioning the upper lid?
The levator palpebrae superioris

What nerve innervates the levator?
CN3

Is levator dysfunction implicated in the ptosis associated with Horner's?
No

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?
The upper lid is too... low
The lower lid is too... high

If Müller's muscle is in the upper lid, what accounts for the Horner-related ptosis of the lower lid?
The lower lid contains a set of smooth-muscle fibers that function in a manner analogous to Müller's muscle, and are innervated in identical fashion. (These LL fibers are less-organized and far weaker than those comprising Müller's muscle.)
Horner Syndrome

- Cause: Sympathetic dysfunction
- Triad:
  - Ptosis

**What muscle is most influential in terms of positioning the upper lid?**
The levator palpebrae superioris

**What nerve innervates the levator?**
CN3

**Is levator dysfunction implicated in the ptosis associated with Horner’s?**
No

With regard to each lid, how is it (mal)positioned in Horner’s?
The upper lid is too...low
The lower lid is too...high

**What nerve innervates the levator?**
CN3

**If Müller’s muscle is in the upper lid, what accounts for the Horner-related ptosis of the lower lid?**
A set of smooth-muscle fibers that function in a manner analogous to Müller’s muscle, and are innervated in identical fashion. (These LL fibers are less-organized and far weaker than those comprising Müller’s muscle.)

**Does this collection of LL smooth muscle fibers have a name?**
Not really (although it is sometimes referred to as the capsulopalpebral muscle because of its location)
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - **Ptosis**

*What muscle is most influential in terms of positioning the upper lid?*
The levator palpebrae superioris

*What nerve innervates the levator?*
CN3

*Is levator dysfunction implicated in the ptosis associated with Horner's?*
No

With regard to each lid, how is it (mal)positioned in ptosis secondary to Horner's?
The upper lid is too... low
The lower lid is too... high

*Does this collection of LL smooth muscle fibers have a name?*
Not really (although it is sometimes referred to as the muscle because of its location)
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis

*What muscle is most influential in terms of positioning the upper lid?*

The levator palpebrae superioris.

*What nerve innervates the levator?*

CN3

*Is levator dysfunction implicated in the ptosis associated with Horner’s?*

No

*If not the levator, what named muscle is implicated in the ptosis associated with Horner’s?*

Müller’s muscle

*Are the fibers in Müller’s muscle striated, or smooth?*

Smooth

*Where is Müller’s muscle located?*

Deep to the distal tendon of the levator; it attaches to the superior border of the tarsal plate of the upper lid.

*If Müller’s muscle is in the upper lid, what accounts for the Horner-related ptosis of the lower lid?*

A set of smooth-muscle fibers that function in a manner analogous to Müller’s muscle, and are innervated in identical fashion. (These LL fibers are less-organized and far weaker than those comprising Müller’s muscle.)

*Does this collection of LL smooth muscle fibers have a name?*

Not really (although it is sometimes referred to as the capsulopalpebral muscle because of its location.)
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis

*How does sympathetic dysfunction result in a relatively miotic pupil?*
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis

How does sympathetic dysfunction result in a relatively miotic pupil?

At any given moment, the size of a pupil is determined by the sum total of sympathetic and parasympathetic innervation being received by its dilator and sphincter muscles, respectively.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - **Miosis**

*How does sympathetic dysfunction result in a relatively miotic pupil?*

At any given moment, the size of a pupil is determined by the sum total of sympathetic and parasympathetic innervation being received by its dilator and sphincter muscles, respectively. Thus, if the amount of sympathetic (=pro-dilation) innervation is reduced in one eye, its relatively unopposed parasympathetic (=pro-miosis) inputs will have an outsized effect, and the pupil will be relatively miosed in comparison to that of the fellow eye.
Horner Syndrome

Horner's miosis in adult

Horner's miosis in infant

Horner syndrome: Miosis
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis

‘Relatively miotic’ implies the pupils are not the same size. What term describes a state of unequal pupil sizes?

How does sympathetic dysfunction result in a relatively miotic pupil? At any given moment, the size of a pupil is determined by the sum total of sympathetic and parasympathetic innervation being received by its dilator and sphincter muscles, respectively. Thus, if the amount of sympathetic (=pro-dilation) innervation is reduced in one eye, its relatively unopposed parasympathetic (=pro-miosis) inputs will have an outsized effect, and the pupil will be relatively miosed in comparison to that of the fellow eye.
Horner Syndrome

- **Cause**: Sympathetic dysfunction
- **Triad**:
  - Ptosis
  - Miosis

‘Relatively miotic’ implies the pupils are not the same size. What term describes a state of unequal pupil sizes? Anisocoria

How does sympathetic dysfunction result in a relatively miotic pupil? At any given moment, the size of a pupil is determined by the sum total of sympathetic and parasympathetic innervation being received by its dilator and sphincter muscles, respectively. Thus, if the amount of sympathetic (=pro-dilation) innervation is reduced in one eye, its relatively unopposed parasympathetic (=pro-miosis) inputs will have an outsized effect, and the pupil will be relatively miosed in comparison to that of the fellow eye.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis

‘Relatively miotic’ implies the pupils are not the same size.
What term describes a state of unequal pupil sizes?

Anisocoria

When faced with anisocoria, what do you want to know first and foremost?

At any given moment, the size of a pupil is determined by the sum total of sympathetic and parasympathetic innervation being received by its dilator and sphincter muscles, respectively. Thus, if the amount of sympathetic (=pro-dilating) innervation is reduced in one eye, its relatively unopposed parasympathetic (=pro-miosing) inputs will have an outsized effect, and its pupil will be relatively miosed in comparison to that of the fellow eye.

When faced with anisocoria, what do you want to know first and foremost?

- Which pupil (if either) is ‘the culprit’; ie, is the larger pupil failing to constrict properly, or is the smaller pupil failing to dilate properly?

- How can you tell which pupil is the culprit?

  - By determining the lighting condition under which the anisocoria is more pronounced. If the anisocoria is more pronounced in dim light, this indicates the smaller pupil isn’t dilating properly, and thus is abnormal. A pupil that fails to dilate is suggestive of a sympathetic problem.

  - Likewise, if the anisocoria is more pronounced in bright light, the larger pupil isn’t constricting properly, and is therefore abnormal. A pupil that doesn’t constrict as it should is suggestive of a parasympathetic problem.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis

‘Relatively miotic’ implies the pupils are not the same size. What term describes a state of unequal pupil sizes?

**Anisocoria**

When faced with anisocoria, what do you want to know first and foremost?
Which pupil (if either) is ‘the culprit’; ie, is the larger pupil failing to constrict properly, or is the smaller pupil failing to dilate properly?

At any given moment, the size of a pupil is determined by the sum total of sympathetic and parasympathetic innervation being received by its dilator and sphincter muscles, respectively. Thus, if the amount of sympathetic (=pro-dilating) innervation is reduced in one eye, its relatively unopposed parasympathetic (=pro-miosis) inputs will have an outsized effect, and its pupil will be relatively miotic in comparison to that of the fellow eye.

Likewise, if the anisocoria is more pronounced in bright light, the larger pupil isn’t constricting properly, and is therefore abnormal. A pupil that doesn’t constrict as it should is suggestive of a parasympathetic problem.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - Anhidrosis

*Horner Syndrome* is characterized by sympathetic dysfunction, resulting in a triad of symptoms including ptosis, miosis, and anhidrosis.

The term *relatively miotic* implies that the pupils are not the same size. What term describes a state of unequal pupil sizes?

When faced with anisocoria, what do you want to know first and foremost?

Which pupil (if either) is ‘the culprit’; i.e., is the larger pupil failing to constrict properly, or is the smaller pupil failing to dilate properly?

How can you tell which pupil is the culprit?

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By determining the lighting condition under which the anisocoria is more pronounced. If the anisocoria is more pronounced in **dim** light, this suggests the smaller pupil isn’t dilating properly, and thus is abnormal. A pupil that fails to dilate is suggestive of a sympathetic problem.
Horner Syndrome

Horner syndrome: Anisocoria greater in dim light
Horner Syndrome

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ANS division
Horner Syndrome

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What if the anisocoria is the same under all lighting conditions?
Then it is nonpathologic or physiological anisocoria (a common finding).
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Horner Syndrome

How does sympathetic dysfunction result in a relatively miotic pupil?

At any given moment, the size of a pupil is determined by the sum total of sympathetic and parasympathetic innervation being received by its dilator and sphincter muscles, respectively. Thus, if the amount of sympathetic (=pro-dilating) innervation is reduced in one eye, its relatively unopposed parasympathetic (=pro-miosing) inputs will have an outsized effect, and its pupil will be relatively miosed in comparison to that of the fellow eye.

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**Hold the phone**: The word ‘suggests’ here seems to indicate it’s possible that anisocoria-greater-in-dim-light isn't necessarily diagnostic of a sympathetic lesion. Is this the case?

It is, unfortunately—physiologic anisocoria sometimes displays the same pattern, ie, it is worse in dim light. This can make differentiating Horners anisocoria from physiologic anisocoria especially challenging.

Is there anything about pupil function that distinguishes a Horner's pupil from a physiologically smaller one?

There is indeed. Whatever dilation in dim light that does occur in the miotic pupil in physiologic anisocoria proceeds at the same speed as the dilation occurring in the fellow pupil. In contrast, in Horner syndrome the miotic eye dilates much slower than its fellow eye. Thus, for the first 4-5 seconds in dim light, the anisocoria will become much more pronounced in a Horner syndrome, a phenomenon not found in physiologic anisocoria.
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There is indeed. Whatever dilation in dim light that does occur in the miotic pupil in physiologic anisocoria proceeds at the same speed as the dilation occurring in the fellow pupil. In contrast, in Horner syndrome the miotic eye dilates much slower than its fellow eye. Thus, for the first 4-5 seconds in dim light, the anisocoria will become much more pronounced in a Horner syndrome, a phenomenon not found in physiologic anisocoria.
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By determining the degree of constriction of each pupil in dim and bright light.

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Thus, for the first 4-5 seconds in dim light, the anisocoria will become much more pronounced in a Horner syndrome, a phenomenon not found in physiologic anisocoria.

**By what name is this phenomenon known?**

Dilation lag
Horner Syndrome

- **Cause:** Sympathetic dysfunction
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  - Ptosis
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Horner Syndrome

How does sympathetic dysfunction result in a relatively miotic pupil?

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By what name is this phenomenon known?

'Dilation lag'
Horner Syndrome

- **Cause:** *Sympathetic dysfunction*
- **Triad:**
  - Ptosis
  - Miosis
  - Anhidrosis

*What does anhidrosis mean?*

- An inability to sweat
- Do Horner pts develop anhidrosis over their entire bodies?
  - No, it is ipsilateral to the lesion, and occurs in one of two patterns of distribution:
    - The head, face and neck (in first-and second-order Horners)
    - The forehead (in third-order Horners)
- What determines which pattern a pt will manifest?
  - The order of the Horners, ie, whether s/he has a first-, second-, or third-order Horner syndrome
Horner Syndrome

- **Cause:** Sympathetic dysfunction
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*What does anhidrosis mean?*
An inability to sweat
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Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - **Anhidrosis**

*What does anhidrosis mean?*
An inability to sweat

*Do Horner pts develop anhidrosis over their entire bodies?*
No, it is ipsilateral to the lesion, and occurs in one of two patterns of distribution:
Horner Syndrome

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  - Ptosis
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--?
--?
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- **Triad:**
  - Ptosis
  - Miosis
  - **Anhidrosis**

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An inability to sweat

*Do Horner pts develop anhidrosis over their entire bodies?*
No, it is ipsilateral to the lesion, and occurs in one of two patterns of distribution:
--The **three locations**
--?
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - **Anhidrosis**

*What does anhidrosis mean?*
An inability to sweat

*Do Horner pts develop anhidrosis over their entire bodies?*
No, it is ipsilateral to the lesion, and occurs in one of two patterns of distribution:
--The head, face and neck
--?
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - Anhidrosis

What does anhidrosis mean?
An inability to sweat

Do Horner pts develop anhidrosis over their entire bodies?
No, it is ipsilateral to the lesion, and occurs in one of two patterns of distribution:
--The head, face and neck
--The one location
Horner Syndrome

- **Cause:** *Sympathetic dysfunction*

- **Triad:**
  - Ptosis
  - Miosis
  - **Anhidrosis**

*What does anhidrosis mean?*
An inability to sweat

*Do Horner pts develop anhidrosis over their entire bodies?*
No, it is ipsilateral to the lesion, and occurs in one of two patterns of distribution:
--The head, face and neck
--The forehead
Horner Syndrome

- **Cause:** *Sympathetic dysfunction*
- **Triad:**
  - Ptosis
  - Miosis
  - **Anhidrosis**

*What does anhidrosis mean?*
An inability to sweat

*Do Horner pts develop anhidrosis over their entire bodies?*
No, it is *ipsilateral to the lesion*, and occurs in one of two patterns of distribution:
-- The head, face and neck
-- The forehead

*What determines which pattern a pt will manifest?*
Horner Syndrome

- **Cause:** *Sympathetic dysfunction*
- **Triad:**
  - Ptosis
  - Miosis
  - **Anhidrosis**

*What does anhidrosis mean?*
An inability to sweat

*Do Horner pts develop anhidrosis over their entire bodies?*
No, it is _ipsilateral_ to the lesion, and occurs in one of two patterns of distribution:
-- The head, face and neck
-- The forehead

*What determines which pattern a pt will manifest?*
The _order_ of the Horners, ie, whether s/he has a first-, second-, or third-order Horner syndrome
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - **Anhidrosis**

*What does anhidrosis mean?*
An inability to sweat

*Do Horner pts develop anhidrosis over their entire bodies?*
No, it is ipsilateral to the lesion, and occurs in one of two patterns of distribution:
  -- The head, face and neck
  -- The forehead

*What determines which pattern a pt will manifest?*
The order of the Horners, ie, whether s/he has a **first-**, **second-**, or **third-order Horner syndrome**
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - **Anhidrosis**

What does anhidrosis mean?
An inability to sweat.

Do Horner pts develop anhidrosis over their entire bodies?
No, it is ipsilateral to the lesion, and occurs in one of two patterns of distribution:
-- The head, face and neck
-- The forehead

What determines which pattern a pt will manifest?
The order of the Horner's, ie, whether s/he has a first-, second-, or third-order Horner syndrome.

What does the word order refer to in this context?
It refers to which neuron in the sympathetic chain—the first, second, or third—isn't working, and is thus responsible for the Horner's. (No worries if you're unsure about this 'sympathetic chain' thing—we will fully unpack this concept shortly.)
Horner Syndrome

- **Cause**: Sympathetic dysfunction
- **Triad**:
  - Ptosis
  - Miosis
  - Anhidrosis

**What does anhidrosis mean?**
An inability to sweat.

**Do Horner pts develop anhidrosis over their entire bodies?**
No, it is ipsilateral to the lesion, and occurs in one of two patterns of distribution:
--The head, face and neck in...?
--The forehead in...?

**What determines which pattern a pt will manifest?**
The *order* of the Horners, ie, whether s/he has a first-, second-, or third-order Horner syndrome.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - Anhidrosis

**What does anhidrosis mean?**
An inability to sweat

**Do Horner pts develop anhidrosis over their entire bodies?**
No, it is **ipsilateral** to the lesion, and occurs in one of two patterns of distribution:

--- The head, face and neck in... first- and second-order Horners
--- The forehead in... third-order Horners

**What determines which pattern a pt will manifest?**
The order of the Horners, i.e., whether s/he has a **first-**, **second-**, or **third-order Horner syndrome**
Horner Syndrome

- **Cause:** Sym pathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - Anhidrosis

What does **anhidrosis** mean? An inability to sweat

Do Horner pts develop anhidrosis over their entire bodies? No, it is ipsilateral to the lesion, and occurs in one of two patterns of distribution:

--- The head, face and neck in…first- and second-order Horners
--- The forehead in…third-order Horners

What determines which pattern a pt will manifest? The *order* of the Horners, ie, whether s/he has a first-, second-, or third-order Horner syndrome

In addition to anhidrosis, the appearance of the ipsilateral face may differ from the other side. In what way?

-- The head, face and neck in…first- and second-order Horners
-- The forehead in…third-order Horners

What *determines* which pattern a pt will manifest? The *order* of the Horners, ie, whether s/he has a first-, second-, or third-order Horner syndrome
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - **Anhidrosis +/- ipsilateral facial**

What does anhidrosis mean? In addition to anhidrosis, the appearance of the ipsilateral face may differ from the other side. In what way? It may be paler vs redder than the unaffected side.

What determines which pattern a pt will manifest? The order of the Horners, ie, whether s/he has a first-, second-, or third-order Horner syndrome.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - **Anhidrosis +/- ipsilateral facial pallor**

*What does anhidrosis mean?*

In addition to anhidrosis, the appearance of the ipsilateral face may differ from the other side. In what way?
It may be paler than the unaffected side.

-- The head, face and neck in...first- and second-order Horners
-- The forehead in...third-order Horners

*What determines which pattern a pt will manifest?*

The order of the Horners, ie, whether s/he has a first-, second-, or third-order Horner syndrome.
Horner Syndrome

- **Cause:** Sympathetic dysfunction
- **Triad:**
  - Ptosis
  - Miosis
  - **Anhidrosis +/- ipsilateral facial pallor**

*What does anhidrosis mean?*

In addition to anhidrosis, the appearance of the ipsilateral face may differ from the other side. In what way? It may be paler than the unaffected side.

*By what name is this phenomenon known?*

- The head, face and neck in...first- and second-order Horners
- The forehead in...third-order Horners

*What determines which pattern a pt will manifest?*

The order of the Horners, ie, whether s/he has a **first-, second-, or third-order Horner syndrome**
Horner Syndrome

- **Cause:** *Sympathetic dysfunction*

- **Triad:**
  - Ptosis
  - Miosis
  - **Anhidrosis +/- ipsilateral facial pallor**

*What does anhidrosis mean?*

In addition to anhidrosis, the appearance of the ipsilateral face may differ from the other side. *In what way?*

It may be paler than the unaffected side.

*By what name is this phenomenon known?*

Harlequin syndrome

-- The head, face and neck in…first- and second-order Horners
-- The forehead in…third-order Horners

*What determines which pattern a pt will manifest?*

The order of the Horners, ie, whether s/he has a **first-, second-,** or **third-order Horner syndrome**
Horner Syndrome

Harlequin syndrome in Horners (note the attendant ptosis and miosis)
(This is a good point in the set to take a break)
Horner Syndrome

Next we will embark on an extensive review of both the sympathetic and parasympathetic pathways as they relate to the eye/orbit. Get comfy—this will take a while!
Horner Syndrome

*Neural pathway in Horner syndrome:*

First of three components

Second of three components

Third of three components
Horner Syndrome

Neural pathway in Horner syndrome:

First-order neurons

Second-order neurons

Third-order neurons
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus

**Second-order neurons**
--Originates at Budge center
--Exits spinal cord
--Travels in sympathetic chain
--Synapses in superior cervical ganglion

**Third-order neurons**
--Originates in superior cervical ganglion
--Travels with internal carotid artery into cavernous sinus
--Hops onto VI, then V1 to enter orbit
Horner Syndrome

**Neural pathway in Horner syndrome:**

**First-order neurons**
--Originate in hypothalamus

**Second-order neurons**

**Third-order neurons**
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in [one word] and [two words]

**Second-order neurons**

**Third-order neurons**
Horner Syndrome

*Neural pathway in Horner syndrome:*  
**First-order neurons**  
--Originate in hypothalamus  
--Travel in brainstem and spinal cord

**Second-order neurons**

**Third-order neurons**
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
-- Originate in hypothalamus
-- Travel in **brainstem** and spinal cord

Second-order neurons

Third-order neurons

As they traverse the brainstem, the first-order fibers pass near the nucleus of a cranial nerve involved in extraocular motility. Which one?
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord

Second-order neurons
As they traverse the brainstem, the first-order fibers pass near the nucleus of a cranial nerve involved in extraocular motility.
Which one?
CN4

Third-order neurons
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in **brainstem** and spinal cord

As they traverse the brainstem, the first-order fibers pass near the nucleus of a cranial nerve involved in extraocular motility.

Which one?
CN4

Can a brainstem lesion bag both structures (ie, the CN4 nucleus and the first-order sympathetic fibers) simultaneously?

Second-order neurons

Third-order neurons
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in **brainstem** and spinal cord

As they traverse the brainstem, the first-order fibers pass near the nucleus of a cranial nerve involved in extraocular motility.

Which one?
CN4

Can a brainstem lesion bag both structures (i.e., the CN4 nucleus and the first-order sympathetic fibers) simultaneously?
Indeed it can
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord

Second-order neurons
As they traverse the brainstem, the first-order fibers pass near the nucleus of a cranial nerve involved in extraocular motility.

Which one?
CN4

Can a brainstem lesion bag both structures (ie, the CN4 nucleus and the first-order sympathetic fibers) simultaneously?
Indeed it can

Third-order neurons
How would such a lesion present clinically?
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord

As they traverse the brainstem, the first-order fibers pass near the nucleus of a cranial nerve involved in extraocular motility.
Which one?
CN4

Can a brainstem lesion bag both structures (ie, the CN4 nucleus and the first-order sympathetic fibers) simultaneously?
Indeed it can

Second-order neurons

How would such a lesion present clinically?
With a Horner syndrome ipsilateral to the lesion and a SO palsy contralateral to the lesion

Third-order neurons
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in **brainstem** and spinal cord

As they traverse the brainstem, the first-order fibers pass near the nucleus of a cranial nerve involved in extraocular motility. Which one?
CN4

Can a brainstem lesion bag both structures (ie, the CN4 nucleus and the first-order sympathetic fibers) simultaneously? Indeed it can

Second-order neurons

Third-order neurons

How would such a lesion present clinically?
With a Horner syndrome **ipsilateral** to the lesion and a SO palsy **contralateral** to the lesion
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord

As they traverse the brainstem, the first-order fibers pass near the nucleus of a cranial nerve involved in extraocular motility. Which one?
CN4

Second-order neurons

Can a brainstem lesion bag both structures (ie, the CN4 nucleus and the first-order sympathetic fibers) simultaneously?
Indeed it can

Third-order neurons

How would such a lesion present clinically?
With a Horner syndrome ipsilateral to the lesion and a SO palsy contralateral to the lesion

Why would the SO palsy be contralateral to the lesion?
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originates in hypothalamus
--Travel in brainstem and spinal cord

As they traverse the brainstem, the first-order fibers pass near the nucleus of a cranial nerve involved in extraocular motility. Which one?
CN4

Second-order neurons

Can a brainstem lesion bag both structures (ie, the CN4 nucleus and the first-order sympathetic fibers) simultaneously?
Indeed it can

Third-order neurons

How would such a lesion present clinically?
With a Horner syndrome ipsilateral to the lesion and a SO palsy contralateral to the lesion

Why would the SO palsy be contralateral to the lesion?
Because control of the SOs is crossed, ie, the right SO muscle is controlled by the left SO nucleus, and vice versa
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the **ciliospinal center of Budge**

**Second-order neurons**

**Third-order neurons**
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

**Second-order neurons**

**Third-order neurons**
Horner Syndrome

*Neural pathway in Horner syndrome:*

First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in **the ciliospinal center of Budge**

Second-order neurons

Third-order neurons

At what level of the spinal cord is the ciliospinal center of Budge found?
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons

At what level of the spinal cord is the ciliospinal center of Budge found?
C8-T2

Third-order neurons
Horner Syndrome

Müller’s muscle
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit two words

Third-order neurons
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

**Second-order neurons**
--Originate at Budge center
--Exit spinal cord

**Third-order neurons**
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

**Second-order neurons**
--Originate at Budge center
--Exit spinal cord
--Travel in... two words

**Third-order neurons**
Horner Syndrome

**Neural pathway in Horner syndrome:**

**First-order neurons**
--Origin in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

**Second-order neurons**
--Origin at Budge center
--Exit spinal cord
--Travel in sympathetic chain

**Third-order neurons**
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain

Third-order neurons

What major structure do these fibers pass over?
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain

Third-order neurons

What major structure do these fibers pass over?
The lung apex
Horner Syndrome

*Neural pathway in Horner syndrome:*

First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain

Third-order neurons

What major structure do these fibers pass over?
The lung apex

Foreshadowing alert!
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in three words

Third-order neurons
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

**Second-order neurons**
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

**Third-order neurons**
Horner Syndrome

Sympathetic pathway: 2nd order neuron
Horner Syndrome

*Neural pathway in Horner syndrome:*
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in *superior cervical ganglion* *aka*...?

Third-order neurons
*By what other name is the superior cervical ganglion known?*
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons

*By what other name is the superior cervical ganglion known?*
The stellate ganglion
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
-- Originate in hypothalamus
-- Travel in brainstem and spinal cord
-- Synapse in the ciliospinal center of Budge

Second-order neurons *aka*...?
-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
-- Synapse in superior cervical ganglion *aka*... the stellate ganglion

Third-order neurons
*By what other name is the superior cervical ganglion known?*
The **stellate ganglion**

*Speaking of other names... The second-order neurons are often referred to by another name, one owing to the relationship between these neurons and the ganglion to which they are headed. What is that name?*
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka...the stellate ganglion*

Third-order neurons
*By what other name is the superior cervical ganglion known?*
The *stellate ganglion*

*Speaking of other names...The second-order neurons are often referred to by another name, one owing to the relationship between these neurons and the ganglion to which they are headed. What is that name?*
*Pre-ganglionic neurons*
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
-- Originate in hypothalamus
-- Travel in brainstem and spinal cord
-- Synapse in the ciliospinal center of Budge

**Second-order neurons** *aka...pre-ganglionic neurons*
-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
-- Synapse in superior cervical ganglion

**Third-order neurons**
-- Originate in superior cervical ganglion
-- Travel with internal carotid artery into cavernous sinus
-- Hop onto VI, then V1 to enter orbit

---

*What neurotransmitter is found in this synapse?*
Horner Syndrome

*Neural pathway in Horner syndrome:*

First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons *aka*... *pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons

*What neurotransmitter is found in this synapse?*
Acetylcholine (ACh)
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons  *aka*...*pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in sympathetic trunk (stellate ganglion)

Third-order neurons

*What neurotransmitter is found in this synapse?*  
Acetylcholine (ACh)

ACh receptors come in two flavors based on their responsiveness to specific chemicals. What are these two flavors?
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the cilioospinal center of Budge

Second-order neurons  aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

What neurotransmitter is found in this synapse?
Acetylcholine (ACh)

ACh receptors come in two flavors based on their responsiveness to specific chemicals.
What are these two flavors?
Muscarinic and nicotinic
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons

ACh receptors come in two flavors based on their responsiveness to specific chemicals.
What are these two flavors?
Muscarinic and nicotinic

Is this synapse muscarinic, or nicotinic?
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

What neurotransmitter is found in this synapse?
Acetylcholine (ACh)

ACh receptors come in two flavors based on their responsiveness to specific chemicals.
What are these two flavors?
Muscarinic and nicotinic

Is this synapse muscarinic, or nicotinic?
Nicotinic
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
-- Originate in hypothalamus
-- Travel in brainstem and spinal cord
-- Synapse in the ciliospinal center of Budge

**Second-order neurons** *aka...pre-ganglionic neurons*
-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
-- Synapse in superior cervical ganglion *aka...the stellate ganglion*

**Third-order neurons**
-- Originate in superior cervical ganglion

*(No question—proceed when ready)*
Horner Syndrome

Sympathetic pathway: 3rd order neuron
Horner Syndrome

*Neural pathway in Horner syndrome:*

- **First-order neurons**
  - Originate in hypothalamus
  - Travel in brainstem and spinal cord
  - Synapse in the ciliospinal center of Budge

- **Second-order neurons** *aka... pre-ganglionic neurons*
  - Originate at Budge center
  - Exit spinal cord
  - Travel in sympathetic chain
  - Synapse in superior cervical ganglion *aka... the stellate ganglion*

- **Third-order neurons** *aka...?*
  - Originate in superior cervical ganglion

*Likewise, the third-order neurons are also referred to by a term owing to their relationship with the stellate ganglion. What is that term?*
Horner Syndrome

*Neural pathway in Horner syndrome:*
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka...the stellate ganglion*

Third-order neurons *aka...post-ganglionic neurons*
--Originate in superior cervical ganglion

*Likewise, the third-order neurons are also referred to by a term owing to their relationship with the stellate ganglion. What is that term?*

**Post-ganglionic** neurons
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
-- Originate in hypothalamus
-- Travel in brainstem and spinal cord
-- Synapse in the ciliospinal center of Budge

**Second-order neurons aka...pre-ganglionic neurons**
-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
-- Synapse in superior cervical ganglion aka...the stellate ganglion

**Third-order neurons aka...post-ganglionic neurons**
-- Originate in superior cervical ganglion
-- Travel with three words to enter the two words
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons aka…pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka…the stellate ganglion

Third-order neurons aka…post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
Horner Syndrome

Sympathetic pathway: 3rd order neuron
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
- Originate in hypothalamus
- Travel in brainstem and spinal cord
- Synapse in the ciliospinal center of Budge

**Second-order neurons** *aka...pre-ganglionic neurons*
- Originate at Budge center
- Exit spinal cord
- Travel in sympathetic chain
- Synapse in superior cervical ganglion *aka...the stellate ganglion*

**Third-order neurons** *aka...post-ganglionic neurons*
- Originate in superior cervical ganglion
- Travel with internal carotid artery to enter the cavernous sinus
- In the sinus:
  ---- Fibers bound for the pupil join *cranial nerve*, then *different cranial nerve*
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
-- Originate in hypothalamus
-- Travel in brainstem and spinal cord
-- Synapse in the ciliospinal center of Budge

**Second-order neurons**  *aka...pre-ganglionic neurons*
-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
-- Synapse in superior cervical ganglion *aka...the stellate ganglion*

**Third-order neurons**  *aka...post-ganglionic neurons*
-- Originate in superior cervical ganglion
-- Travel with internal carotid artery to enter the cavernous sinus
-- In the sinus:
---- Fibers bound for the pupil join CN6, then V1
Horner Syndrome

Sympathetic pathway: 3rd order neuron
Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons  *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain

---*For how long do these pupil-bound postganglionic sympathetic fibers run with CN6?*

--In the sinus:

----*Fibers bound for the pupil join  CN6*, then  V1
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons *aka*...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain

*For how long do these pupil-bound postganglionic sympathetic fibers run with CN6?*
Not long—just a few millimeters

---Fibers bound for the pupil join CN6, then V1
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain

For how long do these pupil-bound postganglionic sympathetic fibers run with CN6?
Not long—just a few millimeters

If it’s so trivial, why bother mentioning the relationship at all?

----Fibers bound for the pupil join CN6, then V1
**Horner Syndrome**

*Neural pathway in Horner syndrome:*
- **First-order neurons**
  - Originate in hypothalamus
  - Travel in brainstem and spinal cord
  - Synapse in the ciliospinal center of Budge

- **Second-order neurons** *aka...pre-ganglionic neurons*
  - Originate at Budge center
  - Exit spinal cord
  - Travel in sympathetic chain

  *For how long do these pupil-bound postganglionic sympathetic fibers run with CN6?*  
  Not long—just a few millimeters

  *If it’s so trivial, why bother mentioning the relationship at all?*  
  Because of its importance in lesion localization. If a pt presents with a LR palsy + ipsilateral miotic pupil, the lesion must be located in the cavernous sinus!

  ----Fibers bound for the pupil join CN6, then V1
Horner Syndrome

Neural pathway in Horner syndrome:

First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1

V1 (aka the [yellow] nerve)
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1

V1 (aka the ophthalmic nerve)

Horner Syndrome

aka…pre-ganglionic neurons
aka…the stellate ganglion
aka…post-ganglionic neurons

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?

With which branch do the postganglionic sympathetics run?
The nasociliary

The nasociliary nerve also carries preganglionic parasympathetics in need of a ganglion in which to synapse. To which ganglion are these fibers headed?
The ciliary ganglion

Upon leaving the ganglion, with which nerves do the sympathetics ride on their way to the dilator muscle?
The long ciliary nerves
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originates in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originates at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originates in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originates in hypothalamus
--Travel in spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons
--Originates at the Budge center
--Exit spinal cord
--Travel in the sympathetic chain
--Synapse in the superior cervical ganglion

Third-order neurons
--Originates in the superior cervical ganglion
--Travel with the internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?

Mnemonic forthcoming…
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?
--N
--F
--L

Mnemonic forthcoming…
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?
--Nasociliary
--Frontal
--Lacrimal

Mnemonic forthcoming…
Horner Syndrome

Ophthalmic nerve (V₁)
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?
--Nasociliary
--Frontal
--Lacrimal

With which branch do the postganglionic sympathetics run?
Horner Syndrome

Neural pathway in Horner syndrome:

First-order neurons:
-- Originate in hypothalamus
-- Travel in spinal cord
-- Synapse in ciliospinal center of Budge

Second-order neurons:
-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
-- Synapse in superior cervical ganglion

Third-order neurons:
-- Originate in superior cervical ganglion
-- Travel with internal carotid artery to enter the cavernous sinus
-- In the sinus:
---- Fibers bound for the pupil join CN6, then V1

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Neural pathway in Horner syndrome:

**First-order neurons**
- Originate in hypothalamus
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- Originate at Budge center
- Exit spinal cord
- Travel in sympathetic chain
- Synapse in superior cervical ganglion

**Third-order neurons**
- Originate in superior cervical ganglion
- Travel with internal carotid artery to enter the cavernous sinus
- In the sinus:
  - Fibers bound for the pupil join CN6, then V1

*V1 (aka the ophthalmic nerve) breaks into three branches. What are they?*
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  - Frontal
  - Lacrimal

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- The nasociliary

*The nasociliary nerve also carries preganglionic parasympathetics in need of a ganglion in which to synapse. To which ganglion are these fibers headed?*
- The ciliary ganglion

*Upon leaving the ganglion, with which nerves do the sympathetics ride on their way to the dilator muscle?*
- The long ciliary nerves
Neural pathway in Horner syndrome:

First-order neurons
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-- Travel in spinal cord
-- Synapse in ciliospinal center of Budge

Second-order neurons
-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
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Third-order neurons
-- Originate in superior cervical ganglion
-- Travel with internal carotid artery to enter the cavernous sinus
-- In the sinus:
---- Fibers bound for the pupil join CN6, then V1

Horner Syndrome aka… pre-ganglionic neurons aka…the stellate ganglion aka… post-ganglionic neurons

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Horner Syndrome

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--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
  ----Fibers bound for the pupil join CN6, then V1

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The ciliary ganglion

Will the sympathetics synapse in the ciliary ganglion as well?
No. Remember, these are postganglionic sympathetics. They will pass through the ganglion without synapsing.
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
  ----Fibers bound for the pupil join CN6, then V1

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Horner Syndrome

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First-order neurons
--Originate in hypothalamus
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?
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With which ganglion are these fibers headed?
The ciliary ganglion

Upon leaving the ganglion, with which nerves do the sympathetics ride on their way to the dilator muscle?
Horner Syndrome

Neural pathway in Horner syndrome:

First-order neurons:
-- Originate in hypothalamus
-- Travel in spinal cord
-- Synapse in ciliospinal center of Budge

Second-order neurons:
-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
-- Synapse in superior cervical ganglion

Third-order neurons:
-- Originate in superior cervical ganglion
-- Travel with internal carotid artery to enter the cavernous sinus
-- In the sinus:
    ---- Fibers bound for the pupil join CN6, then V1

V1 (aka the ophthalmic nerve) breaks into three branches. What are they?
-- Nasociliary
-- Frontal
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With which branch do the postganglionic sympathetics run?
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Upon leaving the ganglion, with which nerves do the sympathetics ride on their way to the dilator muscle?
The long ciliary nerves
Horner Syndrome

Sympathetic pathway: 3rd order neuron
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

**Second-order neurons** *aka*...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka*...the stellate ganglion

**Third-order neurons** *aka*...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1
----Fibers *bound for Mueller’s muscle, as well as*...

*(No question—proceed when ready)*
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

**Second-order neurons** *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka...the stellate ganglion*

**Third-order neurons** *aka...post-ganglionic neurons*
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1
----Fibers bound for Mueller’s muscle, as well as…
----Fibers bound for sweat glands of the forehead hop onto the artery, and then onto its **[highlight]** and **[highlight]** branches
Neural pathway in Horner syndrome:

First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1
----Fibers bound for Mueller’s muscle, as well as…
----Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

Horner Syndrome
Horner Syndrome

Sympathetic pathway overview
Horner Syndrome

Sympathetic supply to the eye.

- Posterior hypothalamus
- Internal carotid artery
- Dilator pupillae muscle
- Superior cervical ganglion
- Sympathetic trunk

Fig. 9.2 See discussion in text.

Sympathetic pathway overview
Horner Syndrome

**Neural pathway in Horner syndrome:**
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons *aka...post-ganglionic neurons*
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1
----Fibers bound for Mueller’s muscle
----Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

*Recall that the NT at this synapse was ACh, specifically of the nicotinic subtype*
Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka…pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons aka…post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1
----Fibers bound for Mueller’s muscle
----Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

Recall that the NT at this synapse was ACh
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
- Originate in hypothalamus
- Travel in brainstem and spinal cord
- Synapse in ciliospinal center of Budge

**Second-order neurons** aka... *pre-ganglionic neurons*
- Originate at Budge center
- Exit spinal cord
- Travel in sympathetic chain
- Synapse in superior cervical ganglion

**Third-order neurons** aka... *post-ganglionic neurons*
- Originate in superior cervical ganglion
- Travel with internal carotid artery to enter the cavernous sinus
- In the sinus:
  ---- Fibers bound for the pupil join CN6, then V1
  ---- Fibers bound for Mueller’s muscle
  ---- Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

Recall that the NT at this synapse was ACh, specifically of the *nicotinic* subtype

*stel late ganglion*
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
-----Fibers bound for the pupil join CN6, then V1
-----Fibers bound for Mueller’s muscle
-----Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

Recall that the NT at this synapse was ACh, specifically of the nicotinic subtype
Neural pathway in Horner syndrome:

First-order neurons
-- Originate in hypothalamus
-- Travel in brainstem and spinal cord
-- Synapse in ciliospinal center of Budge

Second-order neurons
-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
-- Synapse in superior cervical ganglion

Third-order neurons
aka... post-ganglionic neurons
-- Originate in superior cervical ganglion
-- Travel with internal carotid artery to enter the cavernous sinus
  In the sinus:
  -- Fibers bound for the pupil join CN6, then V1
  -- Fibers bound for Mueller’s muscle
  -- Fibers bound for sweat glands
    of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

What about the synapse between the 3rd order neuron and the effector organ—is it ACh as well?

Recall that the NT at this synapse was ACh, specifically of the nicotinic subtype
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
  In the sinus:
  ---- Fibers bound for the pupil join CN6 then V1
  ---- Fibers bound for Mueller’s muscle
  ---- Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

What about the synapse between the 3rd order neuron and the effector organ—is it ACh as well?
No, it is norepinephrine

Recall that the NT at this synapse was ACh, specifically of the nicotinic subtype
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
--- Fibers bound for the pupil join CN6, then V1
--- Fibers bound for Mueller’s muscle
--- Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its ‘frontal’ and ‘lacrimal’ branches

What about the synapse between the 3rd order neuron and the effector organ—is it ACh as well?
No, it is norepinephrine

Recall that the NT at this synapse was ACh, specifically of the nicotinic subtype
Hol up—we never talked about the NT at this synapse. What is it?

- **First-order neurons**
  - Originate in hypothalamus
  - Travel in brainstem and spinal cord
  - Synapse in ciliospinal center of Budge

- **Second-order neurons**
  - Originate at Budge center
  - Exit spinal cord
  - Travel in sympathetic chain
  - Synapse in superior cervical ganglion

- **Third-order neurons**
  - Originate in superior cervical ganglion
  - Travel with internal carotid artery to enter the cavernous sinus
  - In the sinus:
    - Fibers bound for the pupil join CN6, then V1
    - Fibers bound for Mueller’s muscle
    - Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

Recall that the NT at this synapse was ACh, specifically of the nicotinic subtype.

What about the synapse between the 3rd order neuron and the effector organ—is it ACh as well?
- No, it is norepinephrine
- Exit spinal cord
- Travel in sympathetic chain
- Synapse in post-ganglionic neurons of the stellate ganglion

Horner Syndrome

aka...pre-ganglionic neurons
aka...the stellate ganglion
aka...post-ganglionic neurons
Horner Syndrome

First-order neurons
-- Originate in hypothalamus
-- Travel in brainstem and spinal cord
-- Synapse in ciliospinal center of Budge

Second-order neurons
-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
-- Synapse in superior cervical ganglion

Third-order neurons
-- Originate in superior cervical ganglion
-- Travel with internal carotid artery to enter the cavernous sinus
-- In the sinus:
  ---- Fibers bound for the pupil join CN6, then V1
  ---- Fibers bound for Mueller’s muscle
  ---- Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its ‘frontal’ and ‘lacrimal’ branches

Hol up—we never talked about the NT at this synapse. What is it?
I dunno. More importantly, it’s not addressed in any of the BCSC books, so fuggedaboudit.

Recall that the NT at this synapse was ACh, specifically of the nicotinic subtype.

What about the synapse between the 3rd order neuron and the effector organ—is it ACh as well?
No, it is norepinephrine

Third-order neurons aka post-ganglionic neurons
-- Originate in superior cervical ganglion
-- Travel with internal carotid artery to enter the cavernous sinus
-- In the sinus:
  ---- Fibers bound for the pupil join CN6, then V1
  ---- Fibers bound for Mueller’s muscle
  ---- Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its ‘frontal’ and ‘lacrimal’ branches
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons

What about sweat glands of the lower face--how do sympathetics get to them?

----Fibers bound for Mueller's muscle, as well as the rest of the face
----Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches
**Horner Syndrome**

*Neural pathway in Horner syndrome:*
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka...the stellate ganglion*

Third-order neurons *aka...post-ganglionic neurons*

--- *What about sweat glands of the lower face--how do sympathetics get to them?*
--- Postganglionic fibers destined to innervate lower-face sweat glands don’t run with the internal carotid; rather, at the carotid bulb they hop onto the external carotid, then onto its branches to reach their destinations on the non-forehead face
--- Fibers bound for Mueller’s muscle, as well as the rest of the face
--- Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches
Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
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Second-order neurons  aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons  aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

What about fibers bound for the lacrimal gland—do they pass through the cavernous sinus as well?

Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches
Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

What about fibers bound for the lacrimal gland—do they pass through the cavernous sinus as well?
No—these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.
Horner Syndrome

*Neural pathway in Horner syndrome:*
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka...the stellate ganglion*

Third-order neurons *aka...post-ganglionic neurons*
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

*What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?*
No—these hop off the internal carotid *before* it enters the sinus, and join the *preganglionic parasympathetic fibers on their way to innervate the gland*

*Fibers bound for the lacrimal gland? These preganglionic parasympathetic fibers ‘belong’ to which cranial nerve?*
CN7
Horner Syndrome

*Neural pathway in Horner syndrome:*

First-order neurons
-- Originate in hypothalamus
-- Travel in brainstem and spinal cord
-- Synapse in the ciliospinal center of Budge

Second-order neurons *aka...pre-ganglionic neurons*
-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
-- Synapse in superior cervical ganglion *aka...the stellate ganglion*

Third-order neurons *aka...post-ganglionic neurons*
-- Originate in superior cervical ganglion
-- Travel with internal carotid artery to enter the cavernous sinus

*What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?*
No—these hop off the internal carotid *before* it enters the sinus, and join the *preganglionic parasympathetic fibers on their way to innervate the gland*

*Fibers bound for the lacrimal gland?*
These *preganglionic parasympathetic fibers ‘belong’ to which cranial nerve? CN7*
Horner Syndrome

*Neural pathway in Horner syndrome:*

**First-order neurons**
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

**Second-order neurons** *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka...the stellate ganglion*

**Third-order neurons** *aka...post-ganglionic neurons*
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

What about fibers bound for the lacrimal gland—do they pass through the cavernous sinus as well?
No—these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

These preganglionic parasympathetic fibers form a named nerve—what is its name? Cranial nerve?
Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No—these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland

These preganglionic parasympathetic fibers form a named nerve—what is its name?
The greater petrosal nerve
Horner Syndrome

*Neural pathway in Horner syndrome:*
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka...the stellate ganglion*

Third-order neurons *aka...post-ganglionic neurons*
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

*What about fibers bound for the lacrimal gland—do they pass through the*
These postganglionic sympathetic fibers form a named nerve of their own—*what is its name?*

*preganglionic parasympathetic fibers on their way to innervate the gland*

*These preganglionic parasympathetic fibers form a named nerve—what is its name?*
The greater petrosal nerve

*cranial nerve?*
Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons  *aka...pre-ganglionic neurons*
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion *aka...the stellate ganglion*

Third-order neurons  *aka...post-ganglionic neurons*
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

What about *fibers bound for the lacrimal gland*—do they pass through the...?  
These postganglionic sympathetic fibers form a named nerve of their own—what is *its* name?  
The *deep petrosal nerve*

Preganglionic parasympathetic fibers on their way to innervate the gland—
These preganglionic parasympathetic fibers form a named nerve—what is *its* name?  
The *greater petrosal nerve*
**Horner Syndrome**

*Neural pathway in Horner syndrome:*
- First-order neurons
  - Originate in hypothalamus
  - Travel in brainstem and spinal cord
  - Synapse in the ciliospinal center of Budge
- Second-order neurons *aka*..pre-ganglionic neurons
  - Originate at Budge center
  - Exit spinal cord
  - Travel in sympathetic chain
  - Synapse in superior cervical ganglion *aka*..the stellate ganglion
- Third-order neurons *aka*..post-ganglionic neurons
  - Originate in superior cervical ganglion
  - Travel with internal carotid artery to enter the cavernous sinus

*What about fibers bound for the lacrimal gland?* Do they pass through the cavernous sinus as well?
- No—these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

These postganglionic sympathetic fibers form a named nerve—what is its name?
- The deep petrosal nerve
- These postganglionic parasympathetic fibers form a named nerve—what is its name?
- The greater petrosal nerve

Once the deep petrosal and greater petrosal nerves join up, they form a new named nerve—what is its name?
- The vidian nerve
Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

These preganglionic parasympathetic fibers form a named nerve—what is its name?
The deep petrosal nerve

Once the deep petrosal and greater petrosal nerves join up, they form a new named nerve—what is its name?
The vidian nerve
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originates in hypothalamus
--Travels in brainstem and spinal cord
--Synapses in the ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originates at Budge center
--Exits spinal cord
--Travels in sympathetic chain
--Synapses in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originates in superior cervical ganglion
--Travels with internal carotid artery to enter the cavernous sinus

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No--these fibers hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

These postganglionic sympathetic fibers form a new named nerve--what is its name?
The deep petrosal nerve

These preganglionic parasympathetic fibers form a named nerve--what is its name?
The greater petrosal nerve

By what passage does the vidian nerve exit the skull?
The vidian canal

What is the name of the new nerve formed by the deep petrosal and greater petrosal nerves?
The vidian nerve
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion aka...the stellate ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
   ----Fibers bound for the pupil join CN6, then V1
   ----Fibers bound for Mueller's muscle
   ----Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

These postganglionic sympathetic fibers form a named nerve of their own--what is its name?
The deep petrosal nerve

By what passage does the vidian nerve exit the skull?
The vidian canal

The vidian nerve aka...the nerve of the vidian canal

These preganglionic parasympathetic fibers form a named nerve--what is its name?
The greater petrosal nerve

The vidian nerve

What is the cranial nerve?
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Origin in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Origin at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons aka...
--Origin in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
    ----Fibers bound for the pupil join CN6, then V1
    ----Fibers bound for Mueller's muscle
    ----Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

What about fibers bound for the lacrimal gland—do they pass through the cavernous sinus as well?
No—these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland

These postganglionic sympathetic fibers form a named nerve of their own—what is its name?
The deep petrosal nerve

By what passage does the vidian nerve exit the skull?
The vidian canal

The vidian nerve aka...the nerve of the vidian canal

Once the deep petrosal and greater petrosal nerves join up, they form a new named nerve—what is its name?
The vidian nerve

Where is the vidian nerve headed when it leaves the skull?
The pterygopalatine ganglion

Will the sympathetic fibers synapse in the pterygopalatine ganglion?
No, they are postganglionic, and will pass through the ganglion without synapsing. Only the preganglionic parasympathetics will synapse in the pterygopalatine ganglion.
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons aka...post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland

These preganglionic sympathetic fibers form a named nerve of their own--what is its name?
The deep petrosal nerve

Once the deep petrosal and greater petrosal nerves join up, they form a new named nerve--what is its name?
The vidian nerve

By what passage does the vidian nerve exit the skull?
The vidian canal

Where is the vidian nerve headed when it leaves the skull?
The pterygopalatine ganglion

Will the sympathetic fibers synapse in the pterygopalatine ganglion?
No, they are postganglionic, and will pass through the ganglion without synapsing. Only the preganglionic parasympathetics will synapse in the pterygopalatine ganglion.
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons aka...pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons aka...
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus

Where is the vidian nerve headed when it leaves the skull?
The pterygopalatine ganglion

Will the sympathetic fibers synapse in the pterygopalatine ganglion?

By what passage does the vidian nerve exit the skull?
The vidian canal

These postganglionic sympathetic preganglionic parasympathetic fibers on their way to innervate the gland

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetics on their way to innervate the gland

These preganglionic parasympathetic fibers form a named nerve--what is its name?
The greater petrosal nerve

These preganglionic parasympathetic fibers form a named nerve--what is its name?
The deep petrosal nerve

The vidian nerve aka...the nerve of the vidian canal

The vidian nerve

The vidian canal

The cranial nerve?
Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in the ciliospinal center of Budge

Second-order neurons aka…pre-ganglionic neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons aka…post-ganglionic neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
----Fibers bound for the pupil join CN6, then V1
----Fibers bound for Mueller's muscle
----Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

These preganglionic parasympathetic fibers form a named nerve--what is its name?
The deep petrosal nerve
The greater petrosal nerve

What is the deep petrosal nerve exit the skull?
The vidian canal

By what passage does the vidian nerve exit the skull?
The vidian canal

Where is the vidian nerve headed when it leaves the skull?
The pterygopalatine ganglion

Will the sympathetic fibers synapse in the pterygopalatine ganglion?
No, they are postganglionic, and will pass through the ganglion without synapsing. Only the preganglionic parasympathetics will synapse in the pterygopalatine ganglion.

These preganglionic parasympathetic fibers on their way to innervate the gland form a named nerve--what is its name?
The greater petrosal nerve

The deep petrosal nerve

The vidian nerve

The vidian nerve aka…the nerve of the vidian canal

By what passage does the vidian nerve exit the skull?
The vidian canal

These preganglionic parasympathetic fibers form a named nerve—what is its name?
The vidian nerve

What is the vidian nerve headed when it leaves the skull?
The pterygopalatine ganglion

Will the sympathetic fibers synapse in the pterygopalatine ganglion?
No, they are postganglionic, and will pass through the ganglion without synapsing. Only the preganglionic parasympathetics will synapse in the pterygopalatine ganglion.
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
-- Originate in hypothalamus
-- Travel in brainstem and spinal cord

Second-order neurons aka... pre-ganglionic neurons
-- Originate at Budge center
-- Exit spinal cord
-- Travel in sympathetic chain
-- Synapse in superior cervical ganglion

Third-order neurons aka... post-ganglionic neurons
-- Originate in superior cervical ganglion
-- Travel with internal carotid artery to enter the cavernous sinus
  - In the sinus:
    - Fibers bound for the pupil join CN6, then V1
    - Fibers bound for Mueller's muscle
    - Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

What about fibers bound for the lacrimal gland—do they pass through the cavernous sinus as well?
No—these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

These preganglionic parasympathetic fibers form a named nerve of their own—what is its name?
The deep petrosal nerve

The sympathetic fibers synapse in the pterygopalatine ganglion?
No, they are postganglionic, and will pass through the ganglion without synapsing. Only the preganglionic parasympathetics will synapse in the pterygopalatine ganglion.

By what passage does the vidian nerve exit the skull?
The vidian canal aka... the nerve of the vidian canal

Where is the vidian nerve headed when it leaves the skull?
The pterygopalatine ganglion

Will the sympathetic fibers synapse in the pterygopalatine ganglion?
No, they are postganglionic, and will pass through the ganglion without synapsing. Only the preganglionic parasympathetics will synapse in the pterygopalatine ganglion.

These preganglionic parasympathetic fibers form a named nerve—what is its name?
The greater petrosal nerve

Finally: How will the postganglionic sympathetics and (now) postganglionic parasympathetics get to the lacrimal gland?
They will pass through the inferior orbital fissure to join the lacrimal nerve on its way to the gland.
Neural pathway in Horner syndrome:
First-order neurons  
--Originate in hypothalamus 
--Travel in brainstem and spinal cord  
--Synapse in ciliospinal center of Budge
Second-order neurons  
--Originate at Budge center 
--Exit spinal cord  
--Travel in sympathetic chain 
--Synapse in superior cervical ganglion
Third-order neurons  
--Originate in superior cervical ganglion 
--Travel with internal carotid artery to enter the cavernous sinus  
--In the sinus:  
  Fibers bound for the pupil join CN6, then V1  
  Fibers bound for Mueller's muscle  
  Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

Horner Syndrome  
aka...pre-ganglionic neurons  
aka...the stellate ganglion  
aka...post-ganglionic neurons
What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?
No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland

By what passage does the vidian nerve exit the skull?  
The vidian canal  
aka...the nerve of the vidian canal
These postganglionic sympathetic fibers on their way to innervate the gland form a new named nerve--what is its name?  
The deep petrosal nerve  
The greater petrosal nerve  
These preganglionic parasympathetic fibers form a named nerve--what is its name?  
The greater petrosal nerve
Where is the vidian nerve headed when it leaves the skull?
The pterygopalatine ganglion
Will the sympathetic fibers synapse in the pterygopalatine ganglion?
No, they are postganglionic, and will pass through the ganglion without synapsing. Only the preganglionic parasympathetics will synapse in the pterygopalatine ganglion.

Finally: How will the postganglionic sympathetics and (now) postganglionic parasympathetics get to the lacrimal gland?
They will pass through the orbital fissure to join the nerve on its way to the gland

Where is the vidian nerve headed when it leaves the skull?
The pterygopalatine ganglion
Will the sympathetic fibers synapse in the pterygopalatine ganglion?
No, they are postganglionic, and will pass through the ganglion without synapsing. Only the preganglionic parasympathetics will synapse in the pterygopalatine ganglion.

By what passage does the vidian nerve exit the skull?  
The vidian canal  
aka...the nerve of the vidian canal
These postganglionic sympathetic fibers on their way to innervate the gland form a new named nerve--what is its name?  
The deep petrosal nerve  
The greater petrosal nerve  
These preganglionic parasympathetic fibers form a named nerve--what is its name?  
The greater petrosal nerve

Finally: How will the postganglionic sympathetics and (now) postganglionic parasympathetics get to the lacrimal gland?
They will pass through the orbital fissure to join the nerve on its way to the gland
**Horner Syndrome**

**Neural pathway in Horner syndrome:**
- **First-order neurons**
  - Originate in hypothalamus
  - Travel in brainstem and spinal cord
  - Synapse in ciliospinal center of Budge
- **Second-order neurons**
  - Originate at Budge center
  - Exit spinal cord
  - Travel in sympathetic chain
  - Synapse in superior cervical ganglion
- **Third-order neurons**
  - Originate in superior cervical ganglion
  - Travel with internal carotid artery to enter the cavernous sinus
  - In the sinus:
    - Fibers bound for the pupil join CN6, then V1
    - Fibers bound for Muller's muscle
    - Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

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**Horner Syndrome**

**aka...pre-ganglionic neurons**

**aka...the stellate ganglion**

**aka...post-ganglionic neurons**

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?

No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

These postganglionic sympathetic fibers form a named nerve of their own--what is its name?

The deep petrosal nerve

These preganglionic parasympathetic fibers form a named nerve--what is its name?

The greater petrosal nerve

By what passage does the vidian nerve exit the skull?

The vidian canal

**The vidian nerve** aka...the nerve of the vidian canal

Where is the vidian nerve headed when it leaves the skull?

The pterygopalatine ganglion

Will the sympathetic fibers synapse in the pterygopalatine ganglion?

No, they are postganglionic, and will pass through the ganglion without synapsing. Only the preganglionic parasympathetics will synapse in the pterygopalatine ganglion.

These preganglionic parasympathetic fibers 'belong' to which cranial nerve?

CN7

These preganglionic parasympathetic fibers form a named nerve--what is its name?

The greater petrosal nerve

Once the deep petrosal and greater petrosal nerves join up, they form a new named nerve--what is its name?

The vidian nerve

By what passage does the vidian nerve exit the skull?

The vidian canal

Where is the vidian nerve headed when it leaves the skull?

The pterygopalatine ganglion

Will the sympathetic fibers synapse in the pterygopalatine ganglion?

No, they are postganglionic, and will pass through the ganglion without synapsing. Only the preganglionic parasympathetics will synapse in the pterygopalatine ganglion.

Finally: How will the postganglionic sympathetics and (now) postganglionic parasympathetics get to the lacrimal gland?

They will pass through the inferior orbital fissure to join the lacrimal nerve on its way to the gland.

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**Horner Syndrome**

**aka...pre-ganglionic neurons**

**aka...the stellate ganglion**

**aka...post-ganglionic neurons**

What about fibers bound for the lacrimal gland--do they pass through the cavernous sinus as well?

No--these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

These postganglionic sympathetic fibers form a named nerve of their own--what is its name?

The deep petrosal nerve

These preganglionic parasympathetic fibers form a named nerve--what is its name?

The greater petrosal nerve

By what passage does the vidian nerve exit the skull?

The vidian canal

**The vidian nerve** aka...the nerve of the vidian canal

Where is the vidian nerve headed when it leaves the skull?

The pterygopalatine ganglion

Will the sympathetic fibers synapse in the pterygopalatine ganglion?

No, they are postganglionic, and will pass through the ganglion without synapsing. Only the preganglionic parasympathetics will synapse in the pterygopalatine ganglion.

These preganglionic parasympathetic fibers 'belong' to which cranial nerve?

CN7

These preganglionic parasympathetic fibers form a named nerve--what is its name?

The greater petrosal nerve

Once the deep petrosal and greater petrosal nerves join up, they form a new named nerve--what is its name?

The vidian nerve

By what passage does the vidian nerve exit the skull?

The vidian canal

Where is the vidian nerve headed when it leaves the skull?

The pterygopalatine ganglion

Will the sympathetic fibers synapse in the pterygopalatine ganglion?

No, they are postganglionic, and will pass through the ganglion without synapsing. Only the preganglionic parasympathetics will synapse in the pterygopalatine ganglion.

Finally: How will the postganglionic sympathetics and (now) postganglionic parasympathetics get to the lacrimal gland?

They will pass through the inferior orbital fissure to join the lacrimal nerve on its way to the gland.
Horner Syndrome

Neural pathway in Horner syndrome:
First-order neurons
--Originate in hypothalamus
--Travel in brainstem and spinal cord
--Synapse in ciliospinal center of Budge

Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third-order neurons aka pre-ganglionic parasympathetic fibers
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus:
  --- Fibers bound for the pupil join CN6, then V1
  --- Fibers bound for Mueller's muscle
  --- Fibers bound for sweat glands of the forehead hop onto the ophthalmic artery, and then onto its frontal and lacrimal branches

Horner Syndrome aka…pre-ganglionic neurons
aka…the stellate ganglion
aka…post-ganglionic neurons

What about fibers bound for the lacrimal gland—do they pass through the cavernous sinus as well?
No—these hop off the internal carotid before it enters the sinus, and join the preganglionic parasympathetic fibers on their way to innervate the gland.

These postganglionic parasympathetic fibers form a named nerve of their own—what is its name?
The deep petrosal nerve

Once the deep petrosal and greater petrosal nerves join up, they form a new named nerve—what is its name?
The vidian nerve

By what passage does the vidian nerve exit the skull?
The vidian canal

No, they are postganglionic, and will pass through the ganglion without synapsing. Only the preganglionic parasympathetics will synapse in the pterygopalatine ganglion.

These preganglionic parasympathetic fibers form a named nerve—what is its name?
The greater petrosal nerve

The deep petrosal nerve and greater petrosal nerve form the vidian nerve.

Finally: How will the postganglionic sympathetics and (now) postganglionic parasympathetics get to the lacrimal gland?
They will pass through the inferior orbital fissure to join the lacrimal nerve on its way to the gland.

Speaking of parasympathetics: Let’s review its pathway systematically, the way we did the sympathetic one…
**Parasympathetic pathway:**
First-order neurons?

Second-order neurons?

Third-order neurons?

**Speaking of:** *Is the parasympathetic pathway similarly divided into 1st, 2nd and 3rd order neurons?*
**Parasympathetic pathway:**

- **First-order neurons**
  - Originate in hypothalamus
  - Travel in spinal cord
  - Synapse in ciliospinal center of Budge

- **Second-order neurons**
  - Originate at Budge center
  - Exit spinal cord
  - Travel in sympathetic chain
  - Synapse in superior cervical ganglion

- **Third-order neurons**
  - Originate in superior cervical ganglion
  - Travel with internal carotid artery to enter the cavernous sinus
  - In the sinus, hop onto cranial nerve 6, then cranial nerve V1 to enter orbit

**Speaking of:** *Is the parasympathetic pathway similarly divided into 1st, 2nd and 3rd order neurons?*

No. The ‘top’ inputs that influence parasympathetic innervation of the pupil are widely distributed, and cannot reasonably be conceptualized as a unitary ‘first-order neuron.’ (Note: I made up the term ‘top inputs’ for illustrative purposes; it is not used in practice.)
Parasympathetic pathway:

- **First-order neurons**
  - ‘Top’ inputs

- **Second-order neurons**

- **Third-order neurons**

**Speaking of:** *Is the parasympathetic pathway similarly divided into 1st, 2nd and 3rd order neurons?*

No. The ‘top’ inputs that influence parasympathetic innervation of the pupil are widely distributed, and cannot reasonably be conceptualized as a unitary ‘first-order neuron.’ (Note: I made up the term ‘top inputs’ for illustrative purposes; it is not used in practice.) It follows that if there are no 1st-order neurons, the terms *second- and third-order neurons* are not applicable.
**Parasympathetic pathway:**
- First-order neurons: ‘Top’ inputs
- Second-order neurons
- Third-order neurons

**Pre-ganglionic neurons**
- Second-order neurons

**Post-ganglionic neurons**
- Third-order neurons

**Speaking of:** Is the parasympathetic pathway similarly divided into 1\(^{st}\), 2\(^{nd}\) and 3\(^{rd}\) order neurons? No. The ‘top’ inputs that influence parasympathetic innervation of the pupil are widely distributed, and cannot reasonably be conceptualized as a unitary ‘first-order neuron.’ (Note: I made up the term ‘top inputs’ for illustrative purposes; it is not used in practice.) It follows that if there are no 1\(^{st}\)-order neurons, the terms second- and third-order neurons are not applicable. **For this reason, pre- and post-ganglionic are the preferred terms for these neurons.**
Horner Syndrome

*Parasympathetic pathway:*

- First-order neurons -- ‘Top’ inputs
  -- Originate (mainly) in the two words

- Pre-ganglionic neurons
- Second-order neurons

- Post-ganglionic neurons
- Third-order neurons

Horner Syndrome
Horner Syndrome

Parasympathetic pathway:
- First-order neurons ‘Top’ inputs
  -- Originate (mainly) in the pretectal nuclei

Pre-ganglionic neurons
- Second-order neurons

Post-ganglionic neurons
- Third-order neurons
Horner Syndrome

Parasympathetic pathway:
- First-order neurons: ‘Top’ inputs
  - Originate (mainly) in the pretectal nuclei
- Travel in spinal cord
- Synapse in ciliospinal center of Budge

Second-order neurons
- Originate at Budge center
- Exit spinal cord
- Travel in sympathetic chain
- Synapse in superior cervical ganglion

Third-order neurons
- Originate in superior cervical ganglion
- Travel with internal carotid artery to enter the cavernous sinus
- In the sinus, hop onto cranial nerve 6 , then cranial nerve V1 to enter orbit

Where are the pretectal nuclei located?

Pre-ganglionic neurons
- Second-order neurons

Post-ganglionic neurons
- Third-order neurons

Damage to the pretectal nuclei of the dorsal midbrain produces the eponymous syndrome.

Parinaud syndrome (aka dorsal midbrain syndrome, aka pretectal syndrome)

Horner Syndrome
Horner Syndrome

**Parasympathetic pathway:**
- First-order neurons: ‘Top’ inputs
  - Originate (mainly) in the pretectal nuclei
  - Travel in spinal cord
  - Synapse in ciliospinal center of Budge
- Second-order neurons
  - Originate at Budge center
  - Exit spinal cord
  - Travel in sympathetic chain
  - Synapse in superior cervical ganglion
- Third-order neurons
  - Originate in superior cervical ganglion
  - Travel with internal carotid artery to enter the cavernous sinus
  - In the sinus, hop onto cranial nerve 6, then cranial nerve V1 to enter orbit

**Pre-ganglionic neurons**
- Post-ganglionic neurons

*Where are the pretectal nuclei located?*
- The dorsal midbrain

*Damage to the pretectal nuclei of the dorsal midbrain produces what eponymous syndrome?*
- Parinaud syndrome (aka dorsal midbrain syndrome, aka pretectal syndrome)

*Horner Syndrome*
Horner Syndrome

**Parasympathetic pathway:**

- First-order neurons — *‘Top’ inputs*
  -- Originate (mainly) in the pretectal nuclei
  -- Travel in spinal cord
  -- Synapse in ciliospinal center of Budge

- Second-order neurons
  -- Originate at Budge center
  -- Exit spinal cord
  -- Travel in sympathetic chain
  -- Synapse in superior cervical ganglion

- Third-order neurons
  -- Originate in superior cervical ganglion
  -- Travel with internal carotid artery to enter the cavernous sinus
  -- In the sinus, hop onto cranial nerve 6, then cranial nerve V1 to enter orbit

---

Where are the pretectal nuclei located?

The dorsal midbrain

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Damage to the pretectal nuclei of the dorsal midbrain produces what eponymous syndrome?
Horner Syndrome

**Parasympathetic pathway:**
- First-order neurons — ‘Top’ inputs
  - Originate (mainly) in the pretectal nuclei
  - Travel in spinal cord
  - Synapse in ciliospinal center of Budge
- Second-order neurons
  - Originate at Budge center
  - Exit spinal cord
  - Travel in sympathetic chain
  - Synapse in superior cervical ganglion
- Third-order neurons
  - Originate in superior cervical ganglion
  - Travel with internal carotid artery to enter the cavernous sinus
  - In the sinus, hop onto cranial nerve 6, then cranial nerve V1 to enter orbit

**Pre-ganglionic neurons**

**Post-ganglionic neurons**

*Where are the pretectal nuclei located?*
The dorsal midbrain

*Damage to the pretectal nuclei of the dorsal midbrain produces what eponymous syndrome?*
Parinaud syndrome (aka two words syndrome, aka syndrome)
**Parasympathetic pathway:**
- First-order neurons: ‘Top’ inputs
  - Originate (mainly) in the pretectal nuclei
- Second-order neurons
  - Originate at Budge center
  - Exit spinal cord
  - Travel in sympathetic chain
  - Synapse in superior cervical ganglion
- Third-order neurons
  - Originate in superior cervical ganglion
  - Travel with internal carotid artery to enter the cavernous sinus
  - In the sinus, hop onto cranial nerve 6 , then cranial nerve V1 to enter orbit

**Pre-ganglionic neurons**

**Post-ganglionic neurons**

*Where are the pretectal nuclei located?*
The dorsal midbrain

*Damage to the pretectal nuclei of the dorsal midbrain produces what eponymous syndrome?*
Parinaud syndrome (aka dorsal midbrain syndrome, aka pretectal syndrome)
Parasympathetic pathway:
- First-order neurons
  - Originate (mainly) in the pretectal nuclei
  - Travel in spinal cord
  - Synapse in ciliospinal center of Budge
- Second-order neurons
  - Originate at Budge center
  - Exit spinal cord
  - Travel in sympathetic chain
  - Synapse in superior cervical ganglion
- Third-order neurons
  - Originate in superior cervical ganglion
  - Travel with internal carotid artery to enter the cavernous sinus
  - In the sinus, hop onto cranial nerve 6, then cranial nerve V1 to enter orbit

Pre-ganglionic neurons
- Post-ganglionic neurons

Where are the pretectal nuclei located?
The dorsal midbrain

Damage to the pretectal nuclei produces what eponymous syndrome?
Parinaud syndrome

What are the cardinal features of Parinaud syndrome?
- ?
- ?
- ?
- ?

Horner Syndrome
Parasympathetic pathway:
First-order neurons
'Top' inputs
--Originate (mainly) in the pretectal nuclei
--Travel in spinal cord
--Synapse in ciliospinal center of Budge
Second-order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion
Third-order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus, hop onto cranial nerve 6, then cranial nerve V1 to enter orbit

Where are the pretectal nuclei located?
The dorsal midbrain

Pre-ganglionic neurons
Post-ganglionic neurons

What are the cardinal features of Parinaud syndrome?
--Impaired upgaze
--Lid retraction
--Convergence-retraction nystagmus
--Light-near dissociation

Parinaud syndrome
Damage to the pretectal nuclei produces what eponymous syndrome?
**Parasympathetic pathway:**
First order neurons — **‘Top’ inputs**
--Originate (mainly) in the pretectal nuclei
--Travel in spinal cord
--Synapse in ciliospinal center of Budge

Second order neurons
--Originate at Budge center
--Exit spinal cord
--Travel in sympathetic chain
--Synapse in superior cervical ganglion

Third order neurons
--Originate in superior cervical ganglion
--Travel with internal carotid artery to enter the cavernous sinus
--In the sinus, hop onto cranial nerve 6, then cranial nerve V1 to enter orbit

Pre-ganglionic neurons
Post-ganglionic neurons

**Where are the pretectal nuclei located?**
The dorsal midbrain

**Damage to the pretectal nuclei produces what eponymous syndrome?**
**Parinaud syndrome** (aka dorsal midbrain syndrome, aka pretectal syndrome)

**What are the cardinal features of Parinaud syndrome?**
--Impaired upgaze
--Lid retraction
--Convergence-retraction nystagmus
--Light-near dissociation

**What is light-near dissociation?**

---

**Horner Syndrome**
Horner Syndrome

**Parasympathetic pathway:**
- **First-order neurons** -- Originate (mainly) in the pretectal nuclei
- **Travel in spinal cord**
- **Synapse in ciliospinal center of Budge**
- **Second-order neurons** -- Originate at Budge center
- **Exit spinal cord**
- **Travel in sympathetic chain**
- **Synapse in superior cervical ganglion**
- **Third-order neurons** -- Originate in superior cervical ganglion
-- Travel with internal carotid artery to enter the cavernous sinus
-- In the sinus, hop onto cranial nerve 6, then cranial nerve V1 to enter orbit

**Pre-ganglionic neurons**

**Post-ganglionic neurons**

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*Where are the pretectal nuclei located?*  
The dorsal midbrain

*Damage to the pretectal nuclei produces what eponymous syndrome?*  
Parinaud syndrome

*What are the cardinal features of Parinaud syndrome?*  
-- Impaired upgaze
-- Lid retraction
-- Convergence-retraction nystagmus

**Light-near dissociation**

*What is light-near dissociation?*  
A phenomena in which pupils miosis less robustly in response to light than they do as part of the near response
**Horner Syndrome**

**Parasympathetic pathway:**
- First order neurons
  - ‘Top’ inputs
  - Originate mainly in the pretectal nuclei

**Pre-ganglionic neurons**
- Second order neurons
  - Originate in the eponym-eponym nucleus

**Post-ganglionic neurons**
- Third order neurons
Horner Syndrome

**Parasympathetic pathway:**
- First-order neurons: ‘Top’ inputs
  -- Originate mainly in the pretectal nuclei

**Pre-ganglionic neurons**
- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus

**Post-ganglionic neurons**
- Third-order neurons
Parasympathetic pathway:
- First-order neurons – ‘Top’ inputs
  --Originate mainly in the pretectal nuclei

Pre-ganglionic neurons
- Second order neurons
  --Originate in the Edinger-Westphal nucleus

Post-ganglionic neurons
- Third order neurons
  Where in relation to the CN3 nuclear complex is the Edinger-Westphal nucleus located?
**Parasympathetic pathway:**
- First-order neurons: 'Top' inputs
  -- Originate mainly in the pretectal nuclei

**Pre-ganglionic neurons**
- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus

**Post-ganglionic neurons**
- Third-order neurons

*Where in relation to the CN3 nuclear complex is the Edinger-Westphal nucleus located?*
It is a part of the complex.
Horner Syndrome

**Parasympathetic pathway:**
- First order neurons: ‘Top’ inputs
  - Originate mainly in the pretectal nuclei

**Pre-ganglionic neurons**
- Second order neurons
  - Originate in the Edinger-Westphal nucleus
  - Travels with CN3 into the important intracranial space

- Third order neurons

*Post-ganglionic neurons*
Horner Syndrome

**Parasympathetic pathway:**
- First-order neurons: ‘Top’ inputs
  -- Originate mainly in the pretectal nuclei

**Pre-ganglionic neurons**
- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus
  -- Travels with CN3 into the cavernous sinus (CS)

**Post-ganglionic neurons**
- Third-order neurons
**Parasympathetic pathway:**
- First-order neurons — *‘Top’ inputs*
  -- Originate mainly in the pretectal nuclei

**Pre-ganglionic neurons**
- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus
  -- Travels with **CN3** into the cavernous sinus (CS)

---

As ocular-motor nerves go, is CN3 large, or small?
**Parasympathetic pathway:**
- First-order neurons—‘Top’ inputs
  -- Originate mainly in the pretectal nuclei

**Pre-ganglionic neurons**
- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus
  -- Travels with CN3 into the cavernous sinus (CS)

---

**As ocular-motor nerves go, is CN3 large, or small?**
Quite large, with over **#** fibers (contrast that with the itty-bitty CN4 and its **#** fibers)
Horner Syndrome

**Parasympathetic pathway:**
- First-order neurons — ‘Top’ inputs
  - Originate mainly in the pretectal nuclei

**Pre-ganglionic neurons**
- Second-order neurons
  - Originate in the Edinger-Westphal nucleus
  - Travels with CN3 into the cavernous sinus (CS)

As ocular-motor nerves go, is CN3 large, or small?
Quite large, with over 15,000 fibers (contrast that with the itty-bitty CN4 and its 2000 fibers)
Horner Syndrome

Parasympathetic pathway:
First-order neurons
--Originate mainly in the pretectal nuclei

Pre-ganglionic neurons
Second-order neurons
--Originate in the Edinger-Westphal nucleus
--Travels with CN3 into the cavernous sinus (CS)
--Exit CS with inferior division of CN3

Post-ganglionic neurons
Third-order neurons
--Originate in the superior cervical ganglion
--Travel with the internal carotid artery to enter the cavernous sinus
--In the sinus, hop onto cranial nerve 6, then cranial nerve V1 to enter orbit

Top inputs
inferior v
superior
Horner Syndrome

**Parasympathetic pathway:**
- **First-order neurons**
  - ‘Top’ inputs
    - Originate mainly in the pretectal nuclei

**Pre-ganglionic neurons**
- **Second-order neurons**
  - Originate in the Edinger-Westphal nucleus
  - Travels with CN3 into the cavernous sinus (CS)
  - Exit CS with inferior division of CN3

**Post-ganglionic neurons**
- **Third-order neurons**
Horner Syndrome

**Parasympathetic pathway:**
- **First-order neurons**
  - ‘Top’ inputs
  - Originate mainly in the pretectal nuclei

**Pre-ganglionic neurons**
- **Second-order neurons**
  - Originate in the Edinger-Westphal nucleus
  - Travels with CN3 into the cavernous sinus (CS)
  - Exit CS with inferior division of CN3
  - Synapse in ganglion

**Post-ganglionic neurons**
- **Third-order neurons**
Horner Syndrome

**Parasympathetic pathway:**
- First-order neurons
  - ‘Top’ inputs
  - Originate mainly in the pretectal nuclei

**Pre-ganglionic neurons**
- Second-order neurons
  - Originate in the Edinger-Westphal nucleus
  - Travels with CN3 into the cavernous sinus (CS)
  - Exit CS with inferior division of CN3
  - Synapse in ciliary ganglion

**Post-ganglionic neurons**
- Third-order neurons
Parasympathetic pathway:
- First-order neurons -- ‘Top’ inputs
  -- Originate mainly in the pretectal nuclei

Pre-ganglionic neurons
- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus
  -- Travels with CN3 into the cavernous sinus (CS)
  -- Exit CS with inferior division of CN3
  -- Synapse in the ciliary ganglion

Post-ganglionic neurons
- Third-order neurons

Horner Syndrome

Where is the ciliary ganglion located?
**Parasympathetic pathway:**
- First-order neurons
  - ‘Top’ inputs
  - Originate mainly in the pretectal nuclei
- Second-order neurons
  - Originate in the Edinger-Westphal nucleus
  - Travels with CN3 into the cavernous sinus (CS)
  - Exit CS with inferior division of CN3
  - Synapse in the ciliary ganglion
- Third-order neurons
  - Originate in the superior cervical ganglion
  - Travel with internal carotid artery to enter the cavernous sinus
  - In the sinus, hop onto cranial nerve 6, then cranial nerve V1 to enter orbit

**Pre-ganglionic neurons**
- Second-order neurons
  - Originate in the Edinger-Westphal nucleus
  - Travels with CN3 into the cavernous sinus (CS)
  - Exit CS with inferior division of CN3
  - Synapse in the ciliary ganglion

**Post-ganglionic neurons**
- Third-order neurons

**Horner Syndrome**

Where is the ciliary ganglion located?
At the orbital apex
Horner Syndrome

Parasympathetic pathway:
- First-order neurons: ‘Top’ inputs
  -- Originate mainly in the pretectal nuclei

Pre-ganglionic neurons
- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus
  -- Travels with CN3 into the cavernous sinus (CS)
  -- Exit CS with the inferior division of CN3

What neurotransmitter is found in this synapse?

Synapse

Post-ganglionic neurons
- Third-order neurons
  -- Originate in the superior cervical ganglion
  -- Travel with the internal carotid artery to enter the cavernous sinus
  -- In the sinus, hop onto cranial nerve 6, then cranial nerve V1 to enter the orbit

Pre-ganglionic neurons
Post-ganglionic neurons

Horner Syndrome

What neurotransmitter is found in this synapse?

Acetylcholine (same as the pre-post-ganglionic synapse of the sympathetic pathway)
Parasympathetic pathway:
- First-order neurons: ‘Top’ inputs
  -- Originate mainly in the pretectal nuclei
- Pre-ganglionic neurons
  -- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus
  -- Travels with CN3 into the cavernous sinus (CS)
  -- Exit CS with the superior division of CN3
- Post-ganglionic neurons
  -- Third-order neurons
  -- Originate in the superior cervical ganglion
  -- Travel with the internal carotid artery to enter the cavernous sinus
  -- In the sinus, hop onto cranial nerve 6, then cranial nerve V1 to enter the orbit

Pre-ganglionic neurons
- Synapse

What neurotransmitter is found in this synapse?
Acetylcholine (same as the pre↔post-ganglionic synapse of the sympathetic pathway)

Horner Syndrome
Horner Syndrome

Parasympathetic pathway:
- First-order neurons – ‘Top’ inputs
  -- Originate mainly in the pretectal nuclei

Pre-ganglionic neurons
- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus
  -- Travels with CN3 into the cavernous sinus (CS)
  -- Exit CS with inferior division of CN3
  -- Synapse in ciliary ganglion

Post-ganglionic neurons
- Third-order neurons
  -- Originate in superior cervical ganglion
  -- Travel with internal carotid artery to enter the cavernous sinus
  -- In the sinus, hop onto cranial nerve 6 , then cranial nerve V1 to enter orbit

The post-ganglionic ACh receptors of the sympathetic chain were of the nicotinic subtype.

What neurotransmitter is found in this synapse?
Acetylcholine

still remember?
Parasympathetic pathway:
- First-order neurons -- 'Top' inputs
  -- Originate mainly in the pretectal nuclei

Pre-ganglionic neurons
- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus
  -- Travels with CN3 into the cavernous sinus (CS)
  -- Exit CS with inferior division of CN3
  -- Synapse in the ciliary ganglion

Post-ganglionic neurons
- Third-order neurons
  -- Originate in the superior cervical ganglion
  -- Travel with the internal carotid artery to enter the cavernous sinus
  -- In the sinus, hop onto cranial nerve 6, then cranial nerve V1 to enter orbit

The post-ganglionic ACh receptors of the sympathetic chain were of the nicotinic subtype.

Horner Syndrome

What neurotransmitter is found in this synapse? Acetylcholine

(same as the pre→post-ganglionic synapse of the sympathetic pathway)
Parasympathetic pathway:
- First-order neurons
  -- Originate mainly in the pretectal nuclei
  -- Travel in spinal cord
  -- Synapse in ciliospinal center of Budge
- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus
  -- Travels with CN3 into the cavernous sinus (CS)
  -- Exit CS with the inferior division of CN3
  -- Synapse in ciliary ganglion
- Third-order neurons
  -- Originate in superior cervical ganglion
  -- Travel with internal carotid artery to enter the cavernous sinus
  -- In the sinus, hop onto cranial nerve 6, then cranial nerve V1 to enter orbit

Pre-ganglionic neurons
- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus
  -- Travels with CN3 into the cavernous sinus (CS)
  -- Exit CS with the inferior division of CN3
  -- Synapse in ciliary ganglion

What neurotransmitter is found in this synapse? Acetylcholine

The post-ganglionic ACh receptors of the sympathetic chain were of the nicotinic subtype.
How about the post-ganglionic parasympathetics—what type are they?
Parasympathetic pathway:
- First-order neurons: ‘Top’ inputs
  -- Originate mainly in the pretectal nuclei
- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus
  -- Travels with CN3 into the cavernous sinus (CS)
  -- Exit CS with inferior division of CN3
  -- Synapse in ciliary ganglion
- Third-order neurons
  -- Originate in superior cervical ganglion
  -- Travel with internal carotid artery to enter the cavernous sinus
  -- In the sinus, hop onto cranial nerve 6, then cranial nerve V1 to enter orbit

Pre-ganglionic neurons
- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus
  -- Travels with CN3 into the cavernous sinus (CS)
  -- Exit CS with inferior division of CN3
  -- Synapse in ciliary ganglion

Post-ganglionic neurons
- Third-order neurons

The post-ganglionic ACh receptors of the sympathetic chain were of the nicotinic subtype.

How about the post-ganglionic parasympathetics—what type are they?
They too are nicotinic

Horner Syndrome

What neurotransmitter is found in this synapse? Acetylcholine (same as the pre→post-ganglionic synapse of the sympathetic pathway)
Horner Syndrome

**Parasympathetic pathway:**
- **First-order neurons**
  - ‘Top’ inputs
  - Originate mainly in the pretectal nuclei

**Pre-ganglionic neurons**
- **Second-order neurons**
  - Originate in the Edinger-Westphal nucleus
  - Travels with CN3 until the cavernous sinus (CS)
  - Exit CS with inferior division of CN3
  - Synapse in ciliary ganglion

**Post-ganglionic neurons**
- **Third-order neurons**
  - Originate in ciliary ganglion
**Parasympathetic pathway:**
- **First order neurons**  
  -- Originate mainly in the pretectal nuclei

**Pre-ganglionic neurons**
- **Second order neurons**
  -- Originate in the Edinger-Westphal nucleus
  -- Travels with CN3 until the cavernous sinus (CS)
  -- Exit CS with inferior division of CN3
  -- Synapse in ciliary ganglion

**Post-ganglionic neurons**
- **Third order neurons**
  -- Originate in ciliary ganglion
  -- Travel with nerve to the muscle

**‘Top’ inputs**
Horner Syndrome
**Parasympathetic pathway:**

- **First-order neurons**
  - ‘Top’ inputs
  - Originate mainly in the pretectal nuclei

- **Pre-ganglionic neurons**
  - Originate in the Edinger-Westphal nucleus
  - Travels with CN3 until the cavernous sinus (CS)
  - Exit CS with inferior division of CN3
  - Synapse in ciliary ganglion

- **Post-ganglionic neurons**
  - Originate in ciliary ganglion
  - Travel with nerve to the inferior oblique muscle

**Horner Syndrome**
**Horner Syndrome**

*Parasympathetic pathway:*
- **First-order neurons**
  -- Originate mainly in the pretectal nuclei

- **Second-order neurons**
  -- Originate in the Edinger-Westphal nucleus
  -- Travels with CN3 until the cavernous sinus (CS)
  -- Exit CS with inferior division of CN3
  -- Synapse in ciliary ganglion

- **Third-order neurons**
  -- Originate in ciliary ganglion
  -- Travel with nerve to the inferior oblique muscle
  -- At eye, jumps to nerves to reach the sphincter muscle
Horner Syndrome

**Parasympathetic pathway:**
- **First-order neurons**
  - ‘Top’ inputs
  - Originate mainly in the pretectal nuclei

**Pre-ganglionic neurons**
- Second-order neurons
  - Originate in the Edinger-Westphal nucleus
  - Travels with CN3 until the cavernous sinus (CS)
  - Exit CS with inferior division of CN3
  - Synapse in ciliary ganglion

**Post-ganglionic neurons**
- Third-order neurons
  - Originate in ciliary ganglion
  - Travel with nerve to the inferior oblique muscle
  - At eye, jumps to posterior ciliary nerves to reach the sphincter muscle
**Parasympathetic pathway:**

- **First-order neurons**
  - ‘Top’ inputs
  - Originate mainly in the pretectal nuclei

- **Second-order neurons**
  - Originate in the Edinger-Westphal nucleus
  - Travels with CN3 until the cavernous sinus (CS)
  - Exit CS with inferior division of CN3
  - Synapse in ciliary ganglion

- **Third-order neurons**
  - Originate in ciliary ganglion
  - Travel with nerve to the inferior oblique muscle
  - At eye, jumps to posterior ciliary nerves to reach the sphincter muscle

**Pre-ganglionic neurons**

**Post-ganglionic neurons**

Recall that the NT at this synapse was ACh, specifically of the nicotinic subtype.
Horner Syndrome

**Parasympathetic pathway:**
- **First-order neurons**
  -- Originate mainly in the pretectal nuclei
- **Second-order neurons**
  -- Originate in the Edinger-Westphal nucleus
  -- Travels with CN3 until the cavernous sinus (CS)
  -- Exit CS with inferior division of CN3
  -- Synapse in ciliary ganglion
- **Third-order neurons**
  -- Originate in ciliary ganglion
  -- Travel with nerve to the inferior oblique muscle
  -- At eye, jumps to posterior ciliary nerves to reach the sphincter muscle

Pre-ganglionic neurons

Second-order neurons

**Recall that the NT at this synapse was ACh**
Horner Syndrome

Parasympathetic pathway:
- First-order neurons—‘Top’ inputs
  --Originate mainly in the pretectal nuclei

- Pre-ganglionic neurons
- Second-order neurons
  --Originate in the Edinger-Westphal nucleus
  --Travels with CN3 until the cavernous sinus (CS)
  --Exit CS with inferior division of CN3
  --Synapse

- Post-ganglionic neurons
- Third-order neurons
  --Originate in ciliary ganglion
  --Travel with nerve to the inferior oblique muscle
  --At eye, jumps to posterior ciliary nerves to reach the sphincter muscle

Recall that the NT at this synapse was ACh, specifically of the nicotinic subtype.
Horner Syndrome

Parasympathetic pathway:
- **First-order neurons**
  - ‘Top’ inputs
  - Originate mainly in the pretectal nuclei

**Pre-ganglionic neurons**
- **Second-order neurons**
  - Originate in the Edinger-Westphal nucleus
  - Travels with CN3 until the cavernous sinus (CS)
  - Exit CS with inferior division of CN3
  - Synapse

**Recall that the NT at this synapse was ACh, specifically of the nicotinic subtype**

**Post-ganglionic neurons**
- **Third-order neurons**
  - Originate in ciliary ganglion
  - Travel with nerve to the inferior oblique muscle
  - At eye, jumps to posterior ciliary nerves to reach the sphincter muscle
Parasympathetic pathway:
- First-order neurons: ‘Top’ inputs
  -- Originate mainly in the pretectal nuclei
- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus
  -- Travel with CN3 until the cavernous sinus (CS)
  -- Exit CS with inferior division of CN3
  -- Synapse in ciliary ganglion
- Third-order neurons
  -- Originate in ciliary ganglion
  -- Travel with nerve to the inferior oblique muscle
  -- At eye, jumps to posterior ciliary nerves to reach the sphincter muscle

What about the synapse between the 3rd order neuron and the effector organ—what’s the NT there?

Recall that the NT at this synapse was ACh, specifically of the nicotinic subtype

the sphincter muscle
Horner Syndrome

Parasympathetic pathway:
- First-order neurons - 'Top' inputs
  -- Originate mainly in the pretectal nuclei

- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus
  -- Travel with CN3 until the cavernous sinus (CS)
  -- Exit CS with inferior division of CN3
  -- Synapse in ciliary ganglion

- Third-order neurons
  -- Originate in ciliary ganglion
  -- Travel with nerve to the inferior oblique muscle
  -- At eye, jumps to posterior ciliary nerves to reach the sphincter muscle

What about the synapse between the 3rd order neuron and the effector organ—what's the NT there?
It is also ACh

Recall that the NT at this synapse was ACh, specifically of the nicotinic subtype

the sphincter muscle
Parasympathetic pathway:
- First-order neurons: ‘Top’ inputs
  -- Originate mainly in the pretectal nuclei
- Second-order neurons
  -- Originate in the Edinger-Westphal nucleus
  -- Travel with CN3 until the cavernous sinus (CS)
  -- Exit CS with inferior division of CN3
  -- Synapse in ciliary ganglion
- Third-order neurons
  -- Originate in ciliary ganglion
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What about the synapse between the 3rd order neuron and the effector organ—what’s the NT there?
It is also ACh

Is it also nicotinic?

Recall that the NT at this synapse was ACh, specifically of the nicotinic subtype?
Parasympathetic pathway:
- **First-order neurons** – ‘Top’ inputs
  -- Originate mainly in the pretectal nuclei

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-- Originate in the Edinger-Westphal nucleus
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-- Originate in ciliary ganglion
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**What about the synapse between the 3rd order neuron and the effector organ—what’s the NT there?**
It is also ACh

**Is it also nicotinic?**
No, it is **muscarinic**

---
**Pre-ganglionic neurons**
- "Top" inputs

**Post-ganglionic neurons**
- **Third-order neurons**
  -- Originate in ciliary ganglion
  -- Travel with nerve to the inferior oblique muscle
  -- At eye, jumps to posterior ciliary nerves to reach the sphincter muscle

Recall that the NT at this synapse was **ACh**, specifically of the **nicotinic subtype**? **No!**
Horner Syndrome

Summary of the neurotransmitters released and the types of receptors found within the ANS
Horner Syndrome

Key takeaways:

At the pre↔post-ganglionic synapse, both the sympathetic and parasympathetic systems have nicotinic ACh receptors.

Summary of the neurotransmitters released and the types of receptors found within the ANS.
Horner Syndrome

Key takeaways:

At the pre⇋post-ganglionic synapse, both the sympathetic and parasympathetic systems have nicotinic ACh receptors.

At the post-ganglionic⇋effector synapse, the sympathetics have noreppy, whereas the parasympathetics have muscarinic ACh receptors.

Summary of the neurotransmitters released and the types of receptors found within the ANS.
Horner Syndrome

To review neurotransmission and its ophthalmic implications in the somatic nervous system, see slide-set P21
Parasympathetic pathway:
- First-order neurons
  - ‘Top’ input neurons
  - Originate mainly in the pretectal nuclei
  - Travel in spinal cord
  - Synapse in ciliospinal center of Budge
- Second-order neurons
  - Originate in the Edinger-Westphal nucleus
  - Travels with CN3 until the cavernous sinus (CS)
  - Exit CS with inferior division of CN3
  - Synapse in ciliary ganglion
- Third-order neurons
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Finally, and in case you didn’t notice, do: The relative lengths of the pre- and post-ganglionic parasympathetic neurons are opposite of what they were for the sympathetics.
Horner Syndrome

Parasympathetic pathway:

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Finally, and in case you didn’t notice, do: The relative lengths of the pre- and post-ganglionic parasympathetic neurons are opposite of what they were for the sympathetics. In the sympathetic pathway the pre-ganglionic fibers were short, extending from the Budge center to the CNS-adjacent stellate ganglion. The post-ganglionic sympathetic fibers run a long meandering course, using arteries as Ubers to take them through the head to their effector organs.
**Parasympathetic pathway:**

- **First-order neurons**
  - ‘Top’ input
  - Originate mainly in the pretectal nuclei
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**Pre-ganglionic neurons**

- Second-order neurons
  - Originate in the Edinger-Westphal nucleus
  - Travels with CN3 until the cavernous sinus (CS)
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**Post-ganglionic neurons**

- Third-order neurons
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**Horner Syndrome**

*Finally, and in case you didn’t notice, do:* The relative lengths of the pre- and post-ganglionic parasympathetic neurons are opposite of what they were for the sympathetics. *In the sympathetic pathway* the pre-ganglionic fibers were short, extending from the Budge center to the CNS-adjacent stellate ganglion. The post-ganglionic sympathetic fibers run a long meandering course, using arteries as Ubers to take them through the head to their effector organs. In contrast, the parasympathetic system puts its ganglia far from the CNS and near its effectors, thereby necessitating long pre-ganglionic fibers. From these effector-adjacent ganglia, it’s a short hop for the post-ganglionics to reach their targets.
(This is a good point in the set to take a break)
Next we will review some important clinical features of Horner syndrome
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome:
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

Wallenberg syndrome: Central

What is the noneponymous name for Wallenberg syndrome?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central

What is the noneponymous name for Wallenberg syndrome?
Lateral medullary syndrome
Wallenberg (aka *lateral medullary*) syndrome
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

Wallenberg syndrome: Central

What is the noneponymous name for Wallenberg syndrome?
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Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

**Wallenberg syndrome:** Central

**What is the noneponymous name for Wallenberg syndrome?**
Lateral medullary syndrome

**Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion?**
Ipsilateral
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

Wallenberg syndrome: Central

What is the noneponymous name for Wallenberg syndrome?
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Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion?
Ipsilateral

Wallenberg's hallmark symptom is sensory—what is it?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

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Ipsilateral

Wallenberg’s hallmark symptom is sensory—what is it?
Loss of pain and temperature sensation to the ipsilateral face and contralateral body
Wallenberg syndrome: **Central**

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Ipsilateral

**Wallenberg’s hallmark symptom is sensory—what is it?**
Loss of pain and temperature sensation to the **ipsilateral** face and **contralateral** body
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

Wallenberg syndrome: Central

**What is the noneponymous name for Wallenberg syndrome?**
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**Besides the Horner and sensory findings, what are the main signs/symptoms?**
--
--
A

Wallenberg syndrome: Central

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Besides the Horner and sensory findings, what are the main signs/symptoms?
--Cerebellar signs: Disequilibrium, ataxia, nystagmus, skew deviation
--Speech and swallowing difficulties; occasionally, intractable hiccups
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Occlusion of what vessel is implicated in Wallenberg syndrome?
The ipsilateral vertebral or (less commonly) posterior inferior cerebellar artery

Speaking of intractable hiccups: Only two conditions discussed in the BCSC present with them. One is Wallenberg; what is the other?
Neuromyelitis optica spectrum disorder (NMOSD)

In a nutshell, what is NMOSD?
An immune-mediated inflammatory condition of the CNS involving the optic nerve, spinal cord, and various other CNS centers

What is the classic ocular manifestation in NMOSD?
Optic neuritis

What is the classic spinal cord manifestation?
Transverse myelitis

Intractable hiccups implies involvement of what CNS center?
The area postrema

What are the two other symptoms of area postrema syndrome?
--Nausea and vomiting
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

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Week 21

**Wallenberg Syndrome**

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Wallenberg syndrome: Central Horner syndrome is associated with Wallenberg syndrome.

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Wallenberg Syndrome

For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated:

What is the noneponymous name for Wallenberg syndrome?

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Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion?

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For each condition, identify the type of Horner syndrome (central, preganglionic or postganglionic) with which it is associated.

What is the noneponymous name for Wallenberg syndrome?
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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

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Intractable hiccups implies involvement of what CNS center?
The area postrema

What are the two other symptoms of area postrema syndrome?
--Nausea and vomiting

For more on NMOSD, see slide-set N8
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

Wallenberg syndrome: Central

What is the noneponymous name for Wallenberg syndrome?
Lateral medullary syndrome

Speaking of disequilibrium: Wallenberg pts often c/o feeling like their body is being ‘pulled to one side.’ What is the name for this sensation?

Disequilibrium

Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion?
Ipsilateral

Wallenberg’s hallmark symptom is sensory—what is it?
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Besides the Horner and sensory findings, what are the main signs/symptoms?

--Cerebellar signs:
- Disequilibrium
- Ataxia, nystagmus, skew deviation
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Occlusion of what vessel is implicated in Wallenberg syndrome?
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Speaking of disequilibrium: Wallenberg pts often c/o feeling like their body is being ‘pulled to one side.’ What is the name for this sensation?
Lateropulsion

Besides the Horner and sensory findings, what are the main signs/symptoms?
--Cerebellar signs: Disequilibrium, ataxia, nystagmus, skew deviation
--Speech and swallowing difficulties; occasionally, intractable hiccups

Occlusion of what vessel is implicated in Wallenberg syndrome?
The ipsilateral vertebral or (less commonly) posterior inferior cerebellar artery

For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

Central Horner syndrome

Wallenberg’s hallmark symptom is sensory--what is it?
Loss of pain and temperature sensation to the ipsilateral face and contralateral body

In Wallenberg, do pts feel like their being pulled toward the lesion, or away from it?
Toward it

Disequilibrium
What is the noneponymous name for Wallenberg syndrome? Lateral medullary syndrome

Speaking of disequilibrium: Wallenberg pts often c/o feeling like their body is being ‘pulled to one side.’ What is the name for this sensation? Lateropulsion

In Wallenberg, do pts feel like their being pulled toward the lesion side, or away from it? Disequilibrium

- Cerebellar signs: Disequilibrium, ataxia, nystagmus, skew deviation
- Speech and swallowing difficulties; occasionally, intractable hiccups
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

Wallenberg syndrome: Central

What is the noneponymous name for Wallenberg syndrome?
Lateral medullary syndrome

Speaking of disequilibrium: Wallenberg pts often c/o feeling like their body is being ‘pulled to one side.’ What is the name for this sensation?
Lateropulsion

In Wallenberg, do pts feel like their being pulled toward the lesion side, or away from it?
Toward it

Disequilibrium

--Cerebellar signs: disequilibrium, ataxia, nystagmus, skew deviation
--Speech and swallowing difficulties; occasionally, intractable hiccups

Occlusion of what vessel is implicated in Wallenberg syndrome?
The ipsilateral vertebral or (less commonly) posterior inferior cerebellar artery

A
Wallenberg syndrome: Central

What is the non-eponymous name for Wallenberg syndrome?
Lateral medullary syndrome

Speaking of lateropulsion: Wallenberg pts often manifest something called ocular lateropulsion. What are the findings in this condition?

--Lateral-gaze movements toward the lesion side are notably faster than are lateral movements toward the contralateral side
--During vertical saccades, the eyes will move toward the lesion side
--When the pt is not fixating a visual target (eg, during eye closure), the eyes will move into lateral gaze toward the lesion side

In Wallenberg, do pts feel like their body is being ‘pulled’ toward or away from it? Toward it

Speaking of disequilibrium: Wallenberg pts often manifest something called disequilibrium. What are the symptoms?

--Cerebellar signs: ataxia, nystagmus, skew deviation
--Speech and swallowing difficulties; occasionally, intractable hiccups
Wallenberg syndrome: **Central**

**What is the noneponymous name for Wallenberg syndrome?**
Lateral medullary syndrome

**Speaking of lateropulsion: Wallenberg pts often manifest something called ocular lateropulsion. What are the findings in this condition?**
--Lateral-gaze movements toward the lesion side are notably **faster** than lateral movements toward the contralateral side
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**In Wallenberg, do pts feel like they are being pulled to or away from it?**
Toward it

**Lateropulsion**

**Disequilibrium**

**Occlusion of what vessel is implicated in Wallenberg syndrome?**
The ipsilateral vertebral or (less commonly) posterior inferior cerebellar artery

Speaking of disequilibrium: Wallenberg pts often manifest something called lateropulsion. What are the findings in this condition? --Lateral-gaze movements toward the lesion side are notably faster than lateral movements toward the contralateral side

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--Cerebellar signs: Disequilibrium, ataxia, nystagmus, skew deviation
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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- **Wallenberg syndrome:** Central

  - What is the noneponymous name for Wallenberg syndrome? Lateral medullary syndrome.

  - Speaking of lateropulsion: Wallenberg pts often manifest something called **ocular lateropulsion.** What are the findings in this condition?
    - Lateral-gaze movements toward the lesion side are notably faster than are lateral movements toward the contralateral side.

  - In Wallenberg, do pts feel like their body is being 'pulled to one side' or away from it? Toward it.

  - Cerebellar signs: Disequilibrium, ataxia, nystagmus, skew deviation.

  - Speech and swallowing difficulties; occasionally, intractable hiccups.
Wallenberg syndrome: Central

What is the noneponymous name for Wallenberg syndrome?
Lateral medullary syndrome

Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion?
Ipsilateral

Wallenberg's hallmark symptom is sensory--what is it?
Loss of pain and temperature sensation to the ipsilateral face and contralateral body

Besides the Horner and sensory findings, what are the main signs/symptoms?
--Cerebellar signs: Disequilibrium, ataxia, nystagmus, skew deviation
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Disequilibrium

Cerebellar symptoms?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- **Wallenberg syndrome:** Central

  What is the noneponymous name for Wallenberg syndrome?
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  Toward it

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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- **Wallenberg syndrome**: Central

What is the noneponymous name for Wallenberg syndrome?
- Lateral medullar syndrome

Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion?
- Ipsilateral

Wallenberg’s hallmark symptom is sensory—what is it?
- Loss of pain and temperature sensation to the ipsilateral face and contralateral body

Besides the Horner and sensory findings, what are the main signs/symptoms?
- **Cerebellar signs**: Disequilibrium, ataxia, nystagmus, skew deviation
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Wallenberg syndrome: Central

What is the non-eponymous name for Wallenberg syndrome?
Lateral medullary syndrome

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Occlusion of what vessel is implicated in Wallenberg syndrome? The ipsilateral vertebral or (less commonly) posterior inferior cerebellar artery

Wallenberg syndrome is a form of CVA. In that regard: What very common sign/symptom of a CVA is not listed here, ie, is not a component of Wallenberg’s? Paralysis

Why no paralysis in Wallenberg’s? As in real estate, the three most important factors in CVA are location, location, and location. And with respect to CVA location, the general rule is, events that affect the lateral brainstem cause sensory loss, not paralysis (aka “stroke without paralysis”).
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

Wallenberg syndrome: Central

What is the noneponymous name for Wallenberg syndrome? Lateral medullary syndrome

Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion? Ipsilateral

Wallenberg’s hallmark symptom is sensory—what is it? Loss of pain and temperature sensation to the ipsilateral face and contralateral body

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Wallenberg syndrome is a form of CVA. In that regard: What very common sign/symptom of a CVA is not listed here, ie, is not a component of Wallenberg’s? Paralysis or weakness

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Wallenberg's hallmark symptom is sensory—what is it?
Loss of pain and temperature sensation

Besides the Horner and sensory findings, what are the main signs/symptoms?
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Wallenberg syndrome: Central

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Hence Wallenberg's noneponymous name

No question—proceed when ready
Wallenberg syndrome: Central

- **What is the noneponymous name for Wallenberg syndrome?**
  - Lateral medullary syndrome

- **Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion?**
  - Ipsilateral

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  - Loss of pain and temperature sensation to the ipsilateral face and contralateral body

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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- **Wallenberg syndrome**: Central

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  Occlusion of what vessel is implicated in Wallenberg syndrome?
  The ipsilateral vertebral or (less commonly) posterior inferior cerebellar artery

  What mechanism is typically responsible for occluding the vessel in:
  --An older vasculopath?
  --A young adult?
  --A pt with valvular dz, or arrythmia?
What is the noneponymous name for Wallenberg syndrome? Lateral medullary syndrome

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The ipsilateral vertebral or (less commonly) posterior inferior cerebellar artery

For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- What mechanism is typically responsible for occluding the vessel in:
  --An older vasculopath? Atherosclerosis
  --A young adult? Dissection
  --A pt with valvular dz, or arrythmia?

Wallenberg syndrome: Central
Wallenberg syndrome: **Central**

- **What is the noneponymous name for Wallenberg syndrome?**
  - Lateral medullary syndrome

- **Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion?**
  - Ipsilateral

- **Wallenberg’s hallmark symptom is sensory—what is it?**
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Wallenberg syndrome: Central

What is the nonpneumony name for Wallenberg syndrome?
Lateral medullary syndrome

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Wallenberg’s hallmark symptom is sensory—what is it?
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Occlusion of what vessel is implicated in Wallenberg syndrome?
The ipsilateral vertebral or (less commonly) posterior inferior cerebellar artery

What mechanism is typically responsible for occluding the vessel in:
--An older vasculopath? Atherosclerosis
--A young adult? Dissection
--A pt with valvular dz, or arrythmia? Embolism
Wallenberg syndrome: Central

Does Wallenberg carry a good, or poor prognosis?

Lateral medullary syndrome

Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion?
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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

### Wallenberg syndrome: Central

Does Wallenberg carry a good, or poor prognosis? Good—most pts recover with minimal sequelae

Is the Horner pupil in Wallenberg syndrome ipsi- or contralateral to the lesion? Ipsilateral

Wallenberg’s hallmark symptom is sensory--what is it? Loss of pain and temperature sensation to the ipsilateral face and contralateral body

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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma:
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic

If an adult with a pre- or post-ganglionic Horner’s has no history of trauma, what process should be suspected?
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic

If an adult with a pre- or post-ganglionic Horner’s has no history of trauma, what process should be suspected?
An intrathoracic malignancy
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma:
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- Wallenberg syndrome: Central
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Where does Nb rank as a cause of cancer in childhood?

It is the most common cause of extracranial solid cancer (ie, not leukemia) in childhood.

How about in infants (ie, prior to age 12 months)? It is #1.

What proportion of pediatric cancer deaths are due to Nb? 20%.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

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The cancerous cell in NB—the neuroblast—what is it?

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*Where does Nb rank as a cause of cancer in childhood?*
It is the most common cause of extracranial solid cancer (ie, not leukemia) in childhood

*The cancerous cell in NB—the neuroblast—what is it?*
It is the progenitor cell that gives rise to neuron and related cells

*What proportion of peds cancer deaths are due to Nb?*
20%
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Where does Nb rank as a cause of cancer in childhood? It is the most common cause of extracranial solid cancer (ie, not leukemia) in childhood.

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What proportion of pedscancer deaths are due to Nb? 20%

Which ‘neurons’ and ‘related cells’ are involved in Nb, ie, where are the primaries?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- **Wallenberg syndrome**: Central
- **Neck trauma**: Pre- or post-ganglionic
- **Neuroblastoma**: Pre-ganglionic

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What proportion of peds cancer deaths are due to Nb? 20%

Which ‘neurons’ and ‘related cells’ are involved in Nb, ie, where are the primaries? The sympathetic chain, and the adrenal medulla.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- **Neuroblastoma**: Pre-ganglionic

**Where does Nb rank as a cause of cancer in childhood?**
It is the most common cause of extracranial solid cancer (ie, not leukemia) in childhood.

**The cancerous cell in NB—the neuroblast—what is it?**
It is the progenitor cell that gives rise to neuron and related cells.

**What proportion of peds cancer deaths are due to Nb?**
20%

**Of the two sites, which can produce a Horner syndrome?**
The sympathetic chain, and the adrenal medulla.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

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The cancerous cell in NB—the neuroblast—what is it? It is the progenitor cell that gives rise to neuron and related cells.

What proportion of peds cancer deaths are due to Nb? 20%

Of the two sites, which can produce a Horner syndrome? The sympathetic chain (provided the tumor is in the cervical portion) and the adrenal medulla cells.
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
**Neuroblastoma:** Pre-ganglionic

Where does Nb rank as a cause of cancer in childhood?
It is the most common cause of extracranial solid cancer (ie, not leukemia) in childhood

The cancerous cell in NB—the neuroblast—what is it?
It is the progenitor cell that gives rise to neuron and related cells

What proportion of peds cancer deaths are due to Nb?
20%

Of the two sites, which can produce a Horner syndrome?
The sympathetic chain (provided the tumor is in the cervical portion)

Sympathetic chain neurons
Adrenal-medulla cells
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

Primary tumor in sympathetic chain

Horner syndrome 2ndry to Nb
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

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The cancerous cell in NB—the neuroblast—what is it? It is the progenitor cell that gives rise to neuron and related cells.

Neuroblast is notorious for three other ophthalmic manifestations—what are they?

- ?
- ?
- ?

Of the two sites, which can produce a Horner syndrome? The sympathetic chain (provided the tumor is in the cervical portion) and the adrenal medulla.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
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The cancerous cell in NB—the neuroblast—what is it? It is the progenitor cell that gives rise to neuron and related cells.

Nb is notorious for three other ophthalmic manifestations—what are they? --Periorbital ecchymosis (aka)
--?
--?

Of the two sites, which can produce a Horner syndrome? The sympathetic chain (provided the tumor is in the cervical portion) and the adrenal medulla.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

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The cancerous cell in NB—the neuroblast—what is it? It is the progenitor cell that gives rise to neuron and related cells.

Nb is notorious for three other ophthalmic manifestations—what are they? --Periorbital ecchymosis (aka racoon eyes )
--?
--?

Of the two sites, which can produce a Horner syndrome? The sympathetic chain (provided the tumor is in the cervical portion), and the adrenal medulla.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

Nb: ‘Raccoon eyes’
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

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The cancerous cell in NB—the neuroblast—what is it? It is the progenitor cell that gives rise to neuron and related cells.

Sympathetic chain neurons
Adrenal-medulla cells

Of the two sites, which can produce a Horner syndrome? The sympathetic chain (provided the tumor is in the cervical portion) and the adrenal medulla.

Nb is notorious for three other ophthalmic manifestations—what are they?--Periorbital ecchymosis (aka racoon eyes)
--?
--? [an orbit-related issue]
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Where does Nb rank as a cause of cancer in childhood?
It is the most common cause of extracranial solid cancer (ie, not leukemia) in childhood

The cancerous cell in NB—the neuroblast—what is it?
It is the progenitor cell that gives rise to neuron and related cells

Nb is notorious for three other ophthalmic manifestations—what are they?
-- Periorbital ecchymosis (aka racoon eyes)
-- Proptosis
-- ?

Of the two sites, which can produce a Horner syndrome?
The sympathetic chain (provided the tumor is in the cervical portion) and the adrenal medulla.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

Nb: Proptosis
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Where does Nb rank as a cause of cancer in childhood?
It is the most common cause of extracranial solid cancer (ie, not leukemia) in childhood

The cancerous cell in NB—the neuroblast—what is it?
It is the progenitor cell that gives rise to neuron and related cells

Nb is notorious for three other ophthalmic manifestations—what are they?
-- Periorbital ecchymosis (aka racoon eyes )
-- Proptosis
-- ? [an eye-movement issue]

Of the two sites, which can produce a Horner syndrome?
The sympathetic chain (provided the tumor is in the cervical portion) and the adrenal medulla
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
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The cancerous cell in NB—the neuroblast—what is it? It is the progenitor cell that gives rise to neuron and related cells.

 Nb is notorious for three other ophthalmic manifestations—what are they?
--Periorbital ecchymosis (aka raccoon eyes)
--Proptosis
--Opsoclonus

Of the two sites, which can produce a Horner syndrome? The sympathetic chain (provided the tumor is in the cervical portion) and the adrenal medulla.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

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The cancerous cell in NB—the neuroblast—what is it?
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Sympathetic chain neurons
Adrenal-medulla cells

Which ‘neurons’ and ‘related cells’ are involved in Nb, ie, where are the primaries?
The sympathetic chain, and the adrenal medulla.

The sympathetic chain (provided the tumor is in the cervical portion)

Of the two sites, which can produce a Horner syndrome?

- Periorbital ecchymosis (aka racoon eyes)
- Proptosis
- Opsoclonus

What process leads to ecchymosis and/or proptosis?
Orbital metastasis.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Where does Nb rank as a cause of cancer in childhood?
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Sympathetic chain neurons
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Which 'neurons' and 'related cells' are involved in Nb, ie, where are the primaries?
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Of the two sites, which can produce a Horner syndrome?
The sympathetic chain (provided the tumor is in the cervical portion)

Neuroblastoma is notorious for three other ophthalmic manifestations—what are they?
- Periorbital ecchymosis (aka 'raccoon eyes')
- Proptosis
- Opsoclonus

What process leads to ecchymosis and/or proptosis?
Orbital metastasis
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Where does Nb rank as a cause of cancer in childhood?
It is the most common cause of extracranial solid cancer (i.e., not leukemia) in childhood.

The cancerous cell in NB—the neuroblast—what is it?
It is the progenitor cell that gives rise to neuron and related cells.

Sympathetic chain neurons
Adrenal-medulla cells

Which 'neurons' and 'related cells' are involved in Nb, i.e., where are the primaries?
The sympathetic chain, and the adrenal medulla.

Of the two sites, which can produce a Horner syndrome?
The sympathetic chain (provided the tumor is in the cervical portion).

The cancerous cell in NB—what is it?
It is the progenitor cell that gives rise to neuron and related cells.

What is opsoclonus?
A saccadic intrusion characterized by multivectorial, large-amplitude movements.

Is opsoclonus secondary to orbital metastasis, like ecchymosis and proptosis?
No—it is a paraneoplastic phenomenon.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

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Adrenal-medulla cells

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Of the two sites, which can produce a Horner syndrome? The sympathetic chain (provided the tumor is in the cervical portion).

Nb is notorious for three other ophthalmic manifestations—what are they?
- Periorbital ecchymosis (aka raccoon eyes)
- Proptosis
- Opsoclonus

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Adrenal-medulla cells

Which 'neurons' and 'related cells' are involved in Nb, ie, where are the primaries? The sympathetic chain, and the adrenal medulla.

Of the two sites, which can produce a Horner syndrome? The sympathetic chain (provided the tumor is in the cervical portion).

Nb is notorious for three other ophthalmic manifestations—what are they?
- Periorbital ecchymosis (aka raccoon eyes)
- Proptosis
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What is opsoclonus? A saccadic intrusion characterized by multivectorial, large-amplitude movements.

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The cancerous cell in NB—the neuroblast—what is it? It is the progenitor cell that gives rise to neuron and related cells.

Which 'neurons' and 'related cells' are involved in Nb, ie, where are the primaries? The sympathetic chain, and the adrenal medulla.

Of the two sites, which can produce a Horner syndrome? The sympathetic chain (provided the tumor is in the cervical portion).

Is opsoclonus secondary to orbital metastasis, like ecchymosis and proptosis? No—it is a paraneoplastic phenomenon.

What is opsoclonus? A saccadic intrusion characterized by multivectorial, large-amplitude movements.

What are the three other ophthalmic manifestations associated with Nb?--Periorbital ecchymosis (aka racoon eyes)
--Proptosis
--Opsoclonus

Of the two sites, which can produce a Horner syndrome? The sympathetic chain (provided the tumor is in the cervical portion).

The sympathetic chain, and the adrenal medulla.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated:

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Where does Nb rank as a cause of cancer in childhood? It is the most common cause of extracranial solid cancer (ie, not leukemia) in childhood.

The cancerous cell in NB—the neuroblast—what is it? It is the progenitor cell that gives rise to neuron and related cells.

Which 'neurons' and 'related cells' are involved in Nb, ie, where are the primaries? The sympathetic chain, and the adrenal medulla.

Of the two sites, which can produce a Horner syndrome? The sympathetic chain (provided the tumor is in the cervical portion).

Neuroblastoma is notorious for three other ophthalmic manifestations—what are they?
- Periorbital ecchymosis (aka racoon eyes)
- Proptosis
- Opsoclonus

What is opsoclonus? A saccadic intrusion characterized by multivectorial, large-amplitude movements.

Is opsoclonus secondary to orbital metastasis, like ecchymosis and proptosis? No—it is a paraneoplastic phenomenon.
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
Neuroblastoma: Pre-ganglionic

What’s the difference between a saccadic intrusion and a nystagmus?

- Opsoclonus
- Saccadic intrusion

Is opsoclonus secondary to orbital metastasis, like ecchymosis and proptosis?
No—it is a paraneoplastic phenomenon

Of the two eye movements, which is characterized by multivectorial, large-amplitude movements?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- **Neuroblastoma**: Pre-ganglionic

What’s the difference between a saccadic intrusion and a nystagmus?
It’s all in how the event initiates. Both are characterized by involuntary eye movement that displaces fixation from its intended target; ie, the pt is trying to look at something, but their nystagmus/saccadic intrusion ‘pushes’ their eyes off of it.

- **Opsoclonus**
- **saccadic intrusion**
  - Is opsoclonus secondary to orbital metastasis, like ecchymosis and proptosis?
    - No—it is a paraneoplastic phenomenon

Of the two...
The sympathetic chain (provided the tumor is in the cervical portion) and the adrenal medulla...
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

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- Proptosis
- Opsoclonus

Is opsoclonus secondary to orbital metastasis, like ecchymosis and proptosis?
No—it is a paraneoplastic phenomenon

Of the two opsoclonus and saccadic intrusion, which can produce a Horner syndrome?
The sympathetic chain (provided the tumor is in the cervical portion), and the adrenal medulla.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

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Of the two saccadic intrusion
The sympathetic chain (provided the tumor is in the cervical portion)

Is opsoclonus secondary to orbital metastasis, like ecchymosis and proptosis?
No—it is a paraneoplastic phenomenon.

Opsoclonus

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Proptosis
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

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- Proptosis
- **Opsoclonus**

Of the two above, which is characterized by multivectorial, large-amplitude movements?
- **Saccadic intrusion**

Is opsoclonus secondary to orbital metastasis, like ecchymosis and proptosis?
No—it is a paraneoplastic phenomenon

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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

What’s the difference between a saccadic intrusion and a nystagmus? It’s all in how the event initiates. Both are characterized by involuntary eye movement that displaces fixation from its intended target; ie, the pt is trying to look at something, but their nystagmus/saccadic intrusion ‘pushes’ their eyes off of it. It’s in the nature of this initial push: in nystagmus it’s always ‘slow’, whereas in a saccadic intrusion the initial movement is always ‘fast’ (ie, it’s a saccade—hence the name).

For more on nystagmus and/or saccadic intrusions, see set P4

- Proptosis
- Opsoclonus

A saccadic intrusion characterized by multivectorial, large-amplitude movements

Is opsoclonus secondary to orbital metastasis, like ecchymosis and proptosis? No—it is a paraneoplastic phenomenon

Of the two sites, which can produce a Horner syndrome? The sympathetic chain (provided the tumor is in the cervical portion) and the adrenal medulla.
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
Neuroblastoma: Pre-ganglionic
Internal carotid dissection:
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic

What percent of carotid-artery dissection pts will present with a Horner? 
About 60

What systemic conditions predispose to carotid-artery dissection? 
Connective-tissue disorders; eg, Marfan’s and Ehler-Danlos

Is carotid-artery dissection always associated with trauma? 
No, it can occur spontaneously

Name a classic cause of ‘iatrogenic’ (I’m using the term loosely here) carotid-artery dissection: 
Cervical-spine manipulation by a chiropractor
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic

What percent of carotid-artery dissection pts will present with a Horner? About 60
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic

What percent of carotid-artery dissection pts will present with a Horner? About 60

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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
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About 60

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- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
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- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
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- Internal carotid dissection: Post-ganglionic

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Wallenberg syndrome: Central
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- Neck trauma: Pre- or post-ganglionic
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- Internal carotid dissection: Post-ganglionic

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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic

In addition to a Horner's, pts with carotid dissection will likely have two other complaints—what are they?
- ?
- ?

What percent of carotid-artery dissection pts will present with a Horner?
- About 60

What systemic conditions predispose to carotid-artery dissection?
- Connective-tissue disorders; eg, Marfan's and Ehler-Danlos

Is carotid-artery dissection always associated with trauma?
- No, it can occur spontaneously

Name a classic cause of 'iatrogenic' (I'm using the term loosely here) carotid-artery dissection:
- Cervical-spine manipulation by a chiropractor

What unlikely complaints might a carotid-dissection Horner's pt have?
- --Diplopia
- --Dysgeusia
- --Tongue paralysis
- --Facial numbness
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic

In addition to a Horner’s, pts with carotid dissection will likely have two other complaints—what are they?
-- Ipsilateral periorbital
-- ?

What percent of carotid-artery dissection pts will present with a Horner?
About 60

What systemic conditions predispose to carotid-artery dissection?
Connective-tissue disorders; eg, Marfan’s and Ehler-Danlos

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Cervical-spine manipulation by a chiropractor

What unlikely complaints might a carotid-dissection Horner’s pt have?
-- Diplopia
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-- Tongue paralysis
-- Facial numbness
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic

In addition to a Horner's, pts with carotid dissection will likely have two other complaints—what are they?
-- Ipsilateral periorbital pain
-- ?

What percent of carotid-artery dissection pts will present with a Horner?
About 60

What systemic conditions predispose to carotid-artery dissection?
Connective-tissue disorders; eg, Marfan's and Ehler-Danlos

Is carotid-artery dissection always associated with trauma?
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In addition to a Horner's, pts with carotid dissection will likely have two other complaints—what are they?
--Lateral periorbital pain
--Lateral vision disturbances

What percent of carotid-artery dissection pts will present with a Horner?
About 60%

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- Ipsilateral periorbital pain
- Ipsilateral vision disturbances

Can the pain radiate?

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Can the pain radiate?
- It can indeed, to the side or front of the head, or...

What is the classic visual complaint in this scenario?

Name a classic cause of 'iatrogenic' (I'm using the term loosely here) carotid-artery dissection?
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In addition to a Horner's, pts with carotid dissection will likely have two other complaints—what are they?
- Ipsilateral periorbital pain
- Ipsilateral vision disturbances

What are the likely complaints a carotid-dissection Horner's pt might have?
- Diplopia
- Dysgeusia
- Tongue paralysis
- Facial numbness

Can the pain radiate?
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In addition to a Horner's, pts with carotid dissection will likely have two other complaints—what are they?

- Ipsilateral periorbital pain
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Can the pain radiate?

- It can indeed, to the side or front of the head, neck, and/or down the arm.

What is the classic visual complaint in this scenario?

- Recurrent episodes of transient monocular vision loss

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What is dysgeusia?
Altered taste perception

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How could a Horner syndrome possibly involve all this?

Remember, the Horner's is just a manifestation of underlying pathology—in this case, carotid dissection. If the dissection extends to the intracranial portion of the carotid, multiple cranial neuropathies may ensue, with the manifestations listed.

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If carotid dissection is suspected, what is the first step in management? Emergent neuroimaging

What imaging study should be ordered? Angiography—either CTA or MRA

Wouldn’t a carotid doppler study suffice? No, it is not adequate
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What about carotid doppler study—wouldn’t that suffice? No, it is not adequate

Imaging must extend from where to where; ie, what anatomic structures delimit the region that needs to be imaged?

It must extend from the apex of the lung up to the Circle of Willis
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- Internal carotid dissection: Post-ganglionic
- Pancoast tumor:
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**Pancoast tumor**: Pre-ganglionic

What is a Pancoast tumor?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

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- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- **Pancoast tumor**: Pre-ganglionic

*What is a Pancoast tumor?*
A mass at or near the superior sulcus (=apex) of the lung.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

Pancoast tumor
Wallenberg syndrome: Central
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Neuroblastoma: Pre-ganglionic
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Pancoast tumor: Pre-ganglionic
Cluster HA: HA = ‘Headache’ (but we’ll also use it to mean something else a few slides hence)
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

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- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic

Is Horner syndrome a common finding in cluster HA?

Yes—estimates run as high as 50%

So, Horner’s + HA cinches a diagnosis of cluster HA, then?

No!

Remember, dissection of the internal carotid artery is also associated with HA, face and/or eye pain.
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
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Yes—estimates run as high as 50%

So, Horner’s + HA cinches a diagnosis of cluster HA, then?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic

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Yes—estimates run as high as 50%

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No! Remember, dissection of the internal carotid artery is also associated with HA, face and/or eye pain
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
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Is Horner syndrome a common finding in cluster HA?
Yes—estimates run as high as 50%

So, Horner’s + HA cinches a diagnosis of cluster HA, then?
No! Remember, dissection of the internal carotid artery is also associated with HA, face and/or eye pain

**Acute-onset Horner’s + facial/neck pain is an internal carotid dissection until proven otherwise, and must be worked up emergently!**
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery:
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
Neuroblastoma: Pre-ganglionic
Internal carotid dissection: Post-ganglionic
Pancoast tumor: Pre-ganglionic
Cluster HA: Post-ganglionic
Forceps delivery: Pre- or post-ganglionic
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

**Shoulder dystocia** is another cause of congenital Horner’s. Look for a history of complicated birth, along with signs and symptoms of brachial-plexus injury/dysfunction.

Forceps delivery/shoulder dystocia
How does one ‘prove’ a patient has a Horner's?

For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

Cocaine drop testing. Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, a positive response indicates a pre-ganglionic Horner's.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

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- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

How does one ‘prove’ a patient has a Horner’s?
Cocaine drop testing. Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

Why is this? That is, what is it about cocaine drops that allows this assertion to be made?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

How does one ‘prove’ a patient has a Horner’s?
Cocaine drop testing. **Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.**

Why is this? That is, what is it about cocaine drops that allows this assertion to be made?
Cocaine’s mechanism of action is to **block the re-uptake of norepinephrine.** Thus, it can dilate the pupil only if norepinephrine is already present in the neuromuscular junctions of the pupillary dilator muscle. And norepinephrine will be present in the junctions only if the post-ganglionic fibers are being prompted to release it by an intact sympathetic chain. Dysfunction anywhere in the chain will result in the absence of norepinephrine in the neuromuscular junction, and therefore a positive (ie, a failure to dilate) cocaine test.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

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- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

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Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
Neuroblastoma: Pre-ganglionic
Internal carotid dissection: Post-ganglionic
Pancoast tumor: Pre-ganglionic
Cluster HA: Post-ganglionic
Forceps delivery: Pre- or post-ganglionic

How does one ‘prove’ a patient has a Horner’s?
Cocaine drop testing. **Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.**

Why is this? That is, what is it about cocaine drops that allows this assertion to be made?
Cocaine’s mechanism of action is to block the re-uptake of norepinephrine. Thus, it can dilate the pupil only if norepinephrine is already present in the neuromuscular junctions of the pupillary dilator muscle. And norepinephrine will be present in the junctions only if the post-ganglionic fibers are being prompted to release it by an intact sympathetic chain. Dysfunction anywhere in the chain will result in the absence of norepinephrine in the neuromuscular junction, and therefore a positive (ie, a failure to dilate) cocaine test.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

Positive cocaine test (failure of anisocoria to resolve)
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

How does one ‘prove’ a patient has a Horner’s?

Cocaine drop testing. Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner’s?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: **Pre- or post-ganglionic**
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

**How does one ‘prove’ a patient has a Horner’s?**
**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

**How does one differentiate between a pre- and post-ganglionic Horner’s?**
**Hydroxyamphetamine (HA) drop testing.** HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner’s.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

And why is this? That is, what is it about HA drops that allows this assertion to be made?

How does one differentiate between a pre- and post-ganglionic Horner?

Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

And why is this? That is, what is it about HA drops that allows this assertion to be made?

Hair’s mechanism of action is to stimulate the postganglionic fibers to release norepinephrine into the neuromuscular junction. Thus, HA can dilate the pupil only if norepinephrine is in fact present in these bulbs. And norepinephrine will be present in these bulbs only if the post-ganglionic fibers are healthy. If these neurons are damaged—i.e., if the patient has a post-ganglionic Horner syndrome—the degenerated terminal bulbs will have little or no norepinephrine to release, and thus the pupil will dilate poorly or not at all in response to HA. On the other hand, in a central or pre-ganglionic Horner syndrome, the post-ganglionic fibers are intact, and therefore capable of releasing norepinephrine when stimulated to do so by HA.

Why must cocaine drop testing precede HA drop testing?

HA drops cannot distinguish between a preganglionic/central Horner syndrome and a non-Horner eye—the postganglionic fibers are intact for both, so both will dilate in response to HA. Thus, before HA testing is performed, the cocaine test is needed to establish that a Horner syndrome is present.

How does one differentiate between a pre- and post-ganglionic Horners?

Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horners.
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
Neuroblastoma: Pre-ganglionic

And why is this? That is, what is it about HA drops that allows this assertion to be made?
HA’s mechanism of action is to stimulate the postganglionic fibers to release norepinephrine into the neuromuscular junction.

How does one differentiate between a pre- and post-ganglionic Horner’s?
Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner’s.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

And why is this? That is, what is it about HA drops that allows this assertion to be made?
HA’s mechanism of action is to stimulate the postganglionic fibers to release norepinephrine into the neuromuscular junction. Thus, HA can dilate the pupil only if norepinephrine is in fact present in these bulbs, and norepinephrine will be present in these bulbs only if the post-ganglionic fibers are intact. If

How does one differentiate between a pre- and post-ganglionic Horners?
Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horners.
Wallenberg syndrome: Central
Neck trauma: **Pre- or post-ganglionic**
Neuroblastoma: **Pre-ganglionic**

**And why is this?** That is, what is it about HA drops that allows this assertion to be made? HA’s mechanism of action is to stimulate the postganglionic fibers to release norepinephrine into the neuromuscular junction. Thus, HA can dilate the pupil only if norepinephrine is in fact present in these bulbs, and norepinephrine will be present in these bulbs only if the post-ganglionic fibers are intact. If these neurons are damaged—ie, if the pt has a post-ganglionic Horner syndrome—the degenerated terminal bulbs will have little or no norepinephrine to release, and thus the pupil will dilate poorly or not at all in response to HA.

**How does one differentiate between a pre- and post-ganglionic Horners?** Hydroxyamphetamine (HA) drop testing. **HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horners.**
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

And why is this? That is, what is it about HA drops that allows this assertion to be made? HA’s mechanism of action is to stimulate the postganglionic fibers to release norepinephrine into the neuromuscular junction. Thus, HA can dilate the pupil only if norepinephrine is in fact present in these bulbs, and norepinephrine will be present in these bulbs only if the post-ganglionic fibers are intact. If these neurons are damaged—ie, if the pt has a post-ganglionic Horner syndrome—the degenerated terminal bulbs will have little or no norepinephrine to release, and thus the pupil will dilate poorly or not at all in response to HA. On the other hand, in a central or pre-ganglionic Horner syndrome, the post-ganglionic fibers are intact, and therefore capable of releasing norepinephrine when stimulated to do so by HA.

How does one differentiate between a pre- and post-ganglionic Horners? Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horners.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

A. Before drops administered (suspected right Horner syndrome).

HA test
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

A. Before drops administered (suspected right Horner syndrome).
B. After drops administered. Note the dilation of both pupils. This indicates an intact 3rd-order, postganglionic neuron and localizes the lesion to the 1st-order or 2nd-order neuron.

HA test
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
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Why must cocaine drop testing precede HA drop testing?

How does one differentiate between a pre- and post-ganglionic Horners?
Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horners.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

**And why is this?** That is, what is it about HA drops that allows this assertion to be made? HA’s mechanism of action is to stimulate the postganglionic fibers to release norepinephrine into the neuromuscular junction. Thus, HA can dilate the pupil only if norepinephrine is in fact present in these bulbs, and norepinephrine will be present in these bulbs only if the post-ganglionic fibers are intact. If these neurons are damaged—ie, if the pt has a post-ganglionic Horner syndrome—the degenerated terminal bulbs will have little or no norepinephrine to release, and thus the pupil will dilate poorly or not at all in response to HA. On the other hand, in a central or pre-ganglionic Horners, the post-ganglionic fibers are intact, and therefore capable of releasing norepinephrine when stimulated to do so by HA.

**Why must cocaine drop testing precede HA drop testing?**
HA drops cannot distinguish between a preganglionic/central Horner syndrome and a non-Horner eye—the postganglionic fibers are intact for both, so both will dilate in response to HA. Thus, before HA testing is performed, the cocaine test is needed to establish that a Horner syndrome is present.

**How does one differentiate between a pre- and post-ganglionic Horners?**
Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horners.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

And why is this? That is, what is it about HA drops that allows this assertion to be made?
HA’s mechanism of action is to stimulate the postganglionic fibers to release norepinephrine into the neuromuscular junction. Thus, HA can dilate the pupil only if norepinephrine is in fact present in these bulbs, and norepinephrine will be present in these bulbs only if the post-ganglionic fibers are intact. If these neurons are damaged—ie, if the pt has a post-ganglionic Horner syndrome—the degenerated terminal bulbs will have little or no norepinephrine to release, and thus the pupil will dilate poorly or not at all in response to HA. On the other hand, in a central or pre-ganglionic Horners, the post-ganglionic fibers are intact, and therefore capable of releasing norepinephrine when stimulated to do so by HA.

Why must cocaine drop testing precede HA drop testing?
HA drops cannot distinguish between a preganglionic/central Horner syndrome and a non-Horner eye—the postganglionic fibers are intact for both, so both will dilate in response to HA. Thus, before HA testing is performed, the cocaine test is needed to establish that a Horner syndrome is present.

How does one differentiate between a pre- and post-ganglionic Horners?
Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horners (assuming cocaine testing has established that a Horner syndrome is present).
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

How does one ‘prove’ a patient has a Horner’s?
Cocaine drop testing. Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

What is the brand name for HA drops?

Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner's.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: **Pre- or post-ganglionic**
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

How does one ‘prove’ a patient has a Horner’s?
Cocaine drop testing. Cocaine will essentially eliminate anisocoria *if and only if* the sympathetic chain is intact.

What is the brand name for HA drops?
Paredrine

How does one differentiate between a pre- and post-ganglionic Horner’s?
**Hydroxyamphetamine (HA) drop testing.** HA drops will eliminate anisocoria *if* the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner’s.
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
Neuroblastoma: Pre-ganglionic
Internal carotid dissection: Post-ganglionic
Pancoast tumor: Pre-ganglionic
Cluster HA: Post-ganglionic
Forceps delivery: Pre- or post-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

How does one ‘prove’ a patient has a Horner’s?

Cocaine drop testing. Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner’s?

Hydroxyamphetamine (HA) drop testing. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner’s.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

*Transynaptic degeneration*. Pre-ganglionic fiber loss prior to age 10 years leads to transynaptic degeneration of the post-ganglionic fibers. Because of this, the HA response would be negative for a pre- or post-ganglionic lesion originating with a forceps injury. After age 10 years, loss of the pre-ganglionic fibers does not result in transynaptic loss, thus preserving the HA response.

**Forceps delivery: Pre- or post-ganglionic**

How does one ‘prove’ a patient has a Horner’s?

*Cocaine drop testing*. Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner’s?

*Hydroxyamphetamine (HA) drop testing*. HA drops will eliminate anisocoria if the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner’s.
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

What implications does this hold for managing Horner syndrome in children?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

**Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?**

**What implications does this hold for managing Horner syndrome in children?**

It implies one cannot rely on HA testing to differentiate between pre- and post-ganglionic Horner’s in children. Because of this, drop testing cannot be relied upon to rule out neuroblastoma.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

What implications does this hold for managing Horner syndrome in children? It implies one cannot rely on HA testing to differentiate between pre- and post-ganglionic Horner’s in children. Because of this, drop testing cannot be relied upon to rule out neuroblastoma.

Which is more likely to be associated with neuroblastoma: A congenital Horner’s, or one acquired in infancy or early childhood?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

What implications does this hold for managing Horner syndrome in children? It implies one cannot rely on HA testing to differentiate between pre- and post-ganglionic Horner’s in children. Because of this, drop testing cannot be relied upon to rule out neuroblastoma.

Which is more likely to be associated with neuroblastoma: A congenital Horner’s, or one acquired in infancy or early childhood? Acquired Horner’s
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

What implications does this hold for managing Horner syndrome in children?
It implies one cannot rely on HA testing to differentiate between pre- and post-ganglionic Horner’s in children. Because of this, drop testing cannot be relied upon to rule out neuroblastoma.

Which is more likely to be associated with neuroblastoma: A congenital Horner’s, or one acquired in infancy or early childhood?
Acquired Horner’s

Absent a clear trauma history, how should one work up a Horner’s acquired in infancy/early childhood?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

What implications does this hold for managing Horner syndrome in children? It implies one cannot rely on HA testing to differentiate between pre- and post-ganglionic Horner's in children. Because of this, drop testing cannot be relied upon to rule out neuroblastoma.

Which is more likely to be associated with neuroblastoma: A congenital Horner's, or one acquired in infancy or early childhood? Acquired Horner's

Absent a clear trauma history, how should one work up a Horner’s acquired in infancy/early childhood? In addition to a thorough H&P by a pediatrician, urine testing should be undertaken.
Wallenberg syndrome: Central
Neck trauma: Pre- or post-ganglionic
Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

What implications does this hold for managing Horner syndrome in children? It implies one cannot rely on HA testing to differentiate between pre- and post-ganglionic Horner’s in children. Because of this, drop testing cannot be relied upon to rule out neuroblastoma.

Which is more likely to be associated with neuroblastoma: A congenital Horner’s, or one acquired in infancy or early childhood?
Acquired Horner’s

Absent a clear trauma history, how should one work up a Horner’s acquired in infancy/early childhood?
In addition to a thorough H&P by a pediatrician, urine catecholamine (VMA, etc) testing should be undertaken.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated:

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

What implications does this hold for managing Horner syndrome in children?
It implies one cannot rely on HA testing to differentiate between pre- and post-ganglionic Horner’s in children. Because of this, drop testing cannot be relied upon to rule out neuroblastoma.

Which is more likely to be associated with neuroblastoma: A congenital Horner’s, or one acquired in infancy or early childhood?
Acquired Horner’s

Absent a clear trauma history, how should one work up a Horner’s acquired in infancy/early childhood?
In addition to a thorough H&P by a pediatrician, urine catecholamine (VMA, etc) testing should be undertaken.

What does VMA stand for in this context? Hint: It’s not ‘Video Music Awards.’ (Good one Dr Flynn!)
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic

Why will HA drop testing be non-localizing if the Horner syndrome is secondary to a history of neck trauma from forceps delivery?

What implications does this hold for managing Horner syndrome in children?
It implies one cannot rely on HA testing to differentiate between pre- and post-ganglionic Horner’s in children. Because of this, drop testing cannot be relied upon to rule out neuroblastoma.

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What does VMA stand for in this context? Hint: It’s not ‘Video Music Awards.’ (Good one Dr Flynn!)
Vanillylmandelic acid (VMA) is a catecholamine metabolite. Its measurement in urine is used for screening children for catecholamine-secreting tumors such as neuroblastoma.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

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In addition to a thorough H&P by a pediatrician, urine catecholamine (VMA, etc) testing should be undertaken. Careful consideration should be given to imaging the entire sympathetic chain as well.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

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What about a congenital Horner’s—how should that be worked up?
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There is less consensus on this score. If other stigmata of birth trauma are present (eg, brachial plexus injury), a workup is unnecessary.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

In actuality, cocaine and HA drop testing are rarely performed—why?

How does one ‘prove’ a patient has a Horner’s?
**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria *if and only if* the sympathetic chain is intact.

How does one differentiate between a pre- and post-ganglionic Horner’s?
**Hydroxyamphetamine (HA) drop testing.** HA drops will eliminate anisocoria *if* the post-ganglionic neuron is intact; therefore, pupillary dilation indicates a pre-ganglionic/central Horner’s.
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**What drop test can be performed in their stead?**

**Apraclonidine (Iopidine) testing.**

**What is apraclonidine commonly used for?**

An ocular hypotensive, it is used to blunt perioperative pressure spikes.

**What is its mechanism of action?**

It is a nonselective alpha-adrenergic agonist.

**Which alpha receptors are involved in pupil dilation?**

Alpha1

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**How does one ‘prove’ a patient has a Horner's?**

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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
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Which alpha receptors are involved in pupil dilation?

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$\alpha_1$

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An ocular hypotensive, it is used to blunt perioperative pressure spikes

What is its mechanism of action?
It is a nonselective alpha-adrenergic agonist

Which alpha receptors are involved in pupil dilation?
α₁

How is apraclonidine used in diagnosing Horner syndrome?
It is instilled in both eyes. If the anisocoria reverses, the Horner's is confirmed.

How is apraclonidine used to differentiate between a pre- and post-ganglionic Horner's?
It can't

How does one 'prove' a patient has a Horner's?
**Cocaine drop testing.** Cocaine will essentially eliminate anisocoria if and only if the sympathetic chain is intact.

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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
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- Cluster HA: Post-ganglionic
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Which alpha receptors are involved in pupil dilation? $\alpha_1$

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For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

A. Before drops administered (suspected left Horner syndrome).

Apraclonidene testing
Apraclonidine testing

For each condition, identify the type of Horner syndrome (*central, pre-ganglionic or post-ganglionic*) with which it is associated

A. Before drops administered (suspected left Horner syndrome).
B. After drops administered. Note the slight “reversal of anisocoria” in the left eye
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
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What drop test can be performed in their stead? **Apraclonidine (Iopidine) testing**

What is apraclonidine commonly used for?

- **How is apraclonidine used in diagnosing Horner syndrome?**
  It is instilled in both eyes. **If the anisocoria reverses, the Horners is confirmed.**

Which alpha receptors are involved in pupillary dilation: α₁.

What is the physiological basis of anisocoria reversal in response to apraclonidine in Horner syndrome?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: Central
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What drop test can be performed in their stead?
**Apraclonidine (Iopidine) testing**

What is apraclonidine commonly used for?
It is an ocular hypotensive, used to blunt perioperative pressure spikes

**How is apraclonidine used in diagnosing Horner syndrome?**
It is instilled in both eyes. **If the anisocoria reverses, the Horners is confirmed.**

Which alpha receptors are involved in pupil dilation? \(\alpha_1\)

What is the physiological basis of anisocoria reversal in response to apraclonidine in Horner syndrome?
**Denervation supersensitivity.** Horner syndrome results in upregulation of alpha1 receptors on the pupillary dilator muscle of the affected eye; therefore, this eye will exhibit a stronger response to apraclonidine instillation, and will thus dilate to a degree greater than the normal fellow eye.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- **Wallenberg syndrome:** Central
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What is apraclonidine commonly used for? **An ocular hypotensive, it is used to blunt perioperative pressure spikes**

What is its mechanism of action? **It is a nonselective alpha-adrenergic agonist**

Which alpha receptors are involved in pupil dilation? $\alpha_1$

How is apraclonidine used in diagnosing Horner syndrome? It is instilled in both eyes. **If the anisocoria reverses, the Horners is confirmed.**

Which alpha receptors are involved in pupil dilation? $\alpha_1$

How is apraclonidine used to differentiate between a pre- and post-ganglionic Horner? It can’t

How long after the Horner-inciting injury to the sympathetic pathway does it take for denervation supersensitivity to develop? In general, a few days (case reports exist of it occurring in as little as a few hours).

**Denervation supersensitivity**

How long after the Horner-inciting injury to the sympathetic pathway does it take for denervation supersensitivity to develop?
**For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated**

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**What drop test can be performed in their stead?**
***Apraclonidine (Iopidine) testing***

**What is apraclonidine commonly used for?**

*How is apraclonidine used in diagnosing Horner syndrome?*
It is instilled in both eyes. **If the anisocoria reverses, the Horner’s is confirmed.**

*Which α receptors are involved in pupillary dilation?*  
\( \alpha_1 \)

*What drop test can be performed in their stead?*
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*How is apraclonidine used in diagnosing Horner syndrome?*
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**Q**

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_**In actuality, cocaine and HA drop testing are rarely performed—why?**_

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_**What drop test can be performed in their stead?**_

**Apraclonidine (Iopidine) testing**

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**How is apraclonidine used in diagnosing Horner syndrome?**

It is instilled in both eyes. If the anisocoria reverses, the Horner's is confirmed.

_**What is the physiological basis of anisocoria reversal in response to apraclonidine in Horner syndrome?**_

**Denervation supersensitivity.** Horner syndrome results in upregulation of alpha₁ receptors on the pupillary dilator muscle of the affected eye; therefore, this eye will exhibit a stronger response to apraclonidine instillation, and will thus dilate to a degree greater than the normal fellow eye.

_**In addition to anisocoria reversal, what other response to apraclonidine is suggestive of Horner syndrome?**_

**Resolution of ptosis.**

_**What is the pathophysiology of ptosis in Horner syndrome?**_

The absence of sympathetic stimulation to Müller's muscle of the lid produces a mild ptosis.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

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What drop test can be performed in their stead? **Apraclonidine (lopidine) testing**

What is apraclonidine commonly used for?

How is apraclonidine used in diagnosing Horner syndrome? It is instilled in both eyes. If the anisocoria reverses, the Horner's is confirmed.

Which α receptors are involved in pupillary dilation?

What is the physiological basis of anisocoria reversal in response to apraclonidine in Horner syndrome? **Denervation supersensitivity.** Horner syndrome results in upregulation of α₁ receptors on the pupillary dilator muscle of the affected eye; therefore, this eye will exhibit a stronger response to apraclonidine instillation, and will thus dilate to a degree greater than the normal fellow eye.

In addition to anisocoria reversal, what other response to apraclonidine is suggestive of Horner syndrome? Resolution of ptosis.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

A. Before drops administered (suspected left Horner syndrome).
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Apraclonidine testing
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What is apraclonidine commonly used for?

How is apraclonidine used in diagnosing Horner syndrome? It is instilled in both eyes. If the anisocoria reverses, the Horner's is confirmed.

What is the physiological basis of anisocoria reversal in response to apraclonidine in Horner syndrome? **Denervation supersensitivity.** Horner syndrome results in upregulation of alpha_1 receptors on the pupillary dilator muscle of the affected eye; therefore, this eye will exhibit a stronger response to apraclonidine instillation, and will thus dilate to a degree greater than the normal fellow eye.

In addition to anisocoria reversal, what other response to apraclonidine is suggestive of Horner syndrome? Resolution of ptosis.

What is the pathophysiology of ptosis in Horner syndrome?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead? Apraclonidine (Iopidine) testing.

What is apraclonidine commonly used for?

How is apraclonidine used in diagnosing Horner syndrome? It is instilled in both eyes. If the anisocoria reverses, the Horners is confirmed.

Which alpha receptors are involved in pupil dilation?

α1

What is the physiological basis of anisocoria reversal in response to apraclonidine in Horner syndrome? Denervation supersensitivity. Horner syndrome results in upregulation of alpha1 receptors on the pupillary dilator muscle of the affected eye; therefore, this eye will exhibit a stronger response to apraclonidine instillation, and will thus dilate to a degree greater than the normal fellow eye.

In addition to anisocoria reversal, what other response to apraclonidine is suggestive of Horner syndrome? Resolution of ptosis.

What is the pathophysiology of ptosis in Horner syndrome? The absence of sympathetic stimulation to Müller’s muscle of the lid produces a mild ptosis.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead?
**Apraclonidine (Iopidine) testing**

What is apraclonidine commonly used for?
An ocular hypotensive, it is used to blunt perioperative pressure spikes.

How is apraclonidine used in diagnosing Horner syndrome?
It is instilled in both eyes. If the anisocoria reverses, the Horner’s is confirmed.

How is apraclonidine used to differentiate between a pre- and post-ganglionic Horner’s?

How are alpha receptors involved in pupil dilation?
$\alpha_1$

Forceps delivery: Pre- or post-ganglionic
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead?

**Apraclonidine (Iopidine) testing**

What is apraclonidine commonly used for?

*How is apraclonidine used in diagnosing Horner syndrome?*

It is instilled in both eyes. If the anisocoria reverses, the Horner's is confirmed.

*How is apraclonidine used to differentiate between a pre- and post-ganglionic Horner's?*

It can’t.

Which α1 receptors are involved in pupil dilatation?

α1
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead? Apraclonidine (Iopidine) testing

I'm out of apraclonidine. Can I use brimonidine instead?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead? Apraclonidine (lopidine) testing.

I’m out of apraclonidine. Can I use brimonidine instead? I’m afraid not.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead? **Apraclonidine (Iopidine) testing**

*I’m out of apraclonidine. Can I use brimonidine instead?*

I’m afraid not.

*Why not? Aren’t they very similar meds?*
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead?
**Apraclonidine (Iopidine) testing**

I'm out of apraclonidine. Can I use brimonidine instead?
I'm afraid not.

Why not? Aren't they very similar meds?
For purposes of Horner drop-testing, not similar enough. While apraclonidine preferentially stimulates the $\alpha_2$ receptor, it still provides some stimulation of the $\alpha_1$ receptors of the dilator muscles.
In actuality, cocaine and HA drop testing are rarely performed—why? These drugs are highly controlled substances—difficult to acquire and maintain.

What drop test can be performed in their stead? **Apraclonidine (Iopidine) testing**

*I’m out of apraclonidine. Can I use brimonidine instead?*  
I’m afraid not.

*Why not? Aren’t they very similar meds?*  
For purposes of Horner drop-testing, not similar enough. While apraclonidine preferentially stimulates the $\alpha_2$ receptor, it still provides some stimulation of the $\alpha_1$ receptors of the dilator muscles. In contrast, bromonidine is a highly-selective $\alpha_2$ agonist, and as such provides little to no $\alpha_1$ stimulation, and therefore will not induce pupil dilation.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: **Central**
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: **Pre-ganglionic**
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

Which drop test differentiates between a pre-ganglionic and central Horner's?
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: Central
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: Pre-ganglionic
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

Which drop test differentiates between a pre-ganglionic and central Horner's? None. A central Horner's is usually apparent by the company it keeps, or by history.
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated.

- Wallenberg syndrome: **Central**
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: **Pre-ganglionic**
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

Which drop test differentiates between a pre-ganglionic and central Horner's? None. A central Horner's is usually apparent by the company it keeps, or by history.

What sorts of findings would be associated with a central Horner's?

Significant neurological impairment including difficulties with speaking, swallowing and/or balance, as well as disordered movements (ie, a Wallenberg-type scenario).
For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: **Central**
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: **Pre-ganglionic**
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic

Which drop test differentiates between a pre-ganglionic and central Horner's? None. A central Horner's is usually apparent by observation or by history. **the company it keeps**.

What sorts of findings would be associated with a central Horner's? Significant neurological impairment including difficulties with speaking, swallowing and/or balance, as well as disordered movements (i.e., a Wallenberg-type scenario).
Which drop test differentiates between a pre-ganglionic and central Horners? None. A central Horners is usually apparent by the company it keeps, or by history.

What history would be associated with a central Horners?

For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated

- Wallenberg syndrome: **Central**
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: **Pre-ganglionic**
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic
Which drop test differentiates between a pre-ganglionic and central Horner syndrome? None. A central Horner syndrome is usually apparent by the company it keeps, or by history.

What history would be associated with a central Horner syndrome? Associated history could include significant intracranial events (CVA, tumor, meningitis, a bleed) or a history of significant high C-spine trauma (fracture, dislocation).

For each condition, identify the type of Horner syndrome (central, pre-ganglionic or post-ganglionic) with which it is associated:

- Wallenberg syndrome: **Central**
- Neck trauma: Pre- or post-ganglionic
- Neuroblastoma: **Pre-ganglionic**
- Internal carotid dissection: Post-ganglionic
- Pancoast tumor: Pre-ganglionic
- Cluster HA: Post-ganglionic
- Forceps delivery: Pre- or post-ganglionic
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck
- Upper chest

...with attention to the:

- Skull base
- Internal carotid artery (esp. at the skull base)
- Paraspinal area
- Mediastinum
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck
- Upper chest
- Skull base
- Internal carotid artery (esp. at the skull base)
- Paraspinal area
- Mediastinum
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head

...with attention to the:

- specific aspect of head
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head

…with attention to the:

- Skull base
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- **Head**
- **Neck**
- **Upper chest**

...with attention to the:

- **Skull base**
- **Internal carotid artery (esp. at the skull base)**
- **Paraspinal area**
- **Mediastinum**
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck

...with attention to the:

- Skull base
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck

...with attention to the:

- Skull base

  specific structure in neck
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck

...with attention to the:

- Skull base
- Internal carotid artery
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck

...with attention to the:

- Skull base
- Internal carotid artery
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck
- Upper chest

...with attention to the:

- Skull base
- Internal carotid artery
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck
- Upper chest

...with attention to the:

- Skull base
- Internal carotid artery
  
  specific aspect of chest 1
  
  specific aspect of chest 2
Unless congenital, and absent a definite trauma history, a Horner syndrome must be worked up with imaging of the:

- Head
- Neck
- Upper chest

...with attention to the:

- Skull base
- Internal carotid artery
- Paraspinal area
- Mediastinum