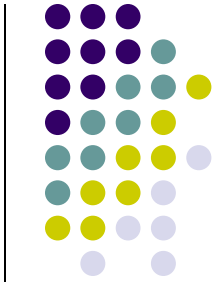
Q

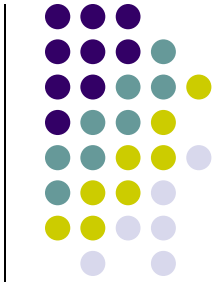
Sherrington's Law vs Hering's Law



- Define **Sherrington's law**
  - **Sherrington's law**: increased *vs* decreased innervation to a muscle is accompanied by increased *vs* decreased innervation to its antagonist

A

Sherrington's Law vs Hering's Law



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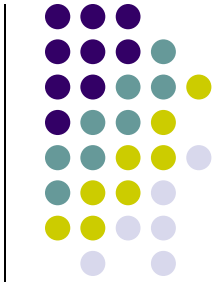
Sherrington's Law vs Hering's Law



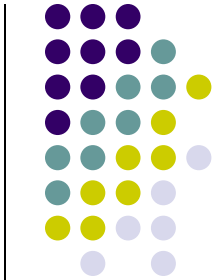
- Define **Sherrington's law**

  - **Sherrington's law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist

What is the full name of Sherrington's law?
Sherrington's law of…

A

Sherrington's Law vs Hering's Law



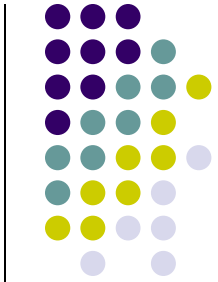
- Define **Sherrington's law**

  - **Sherrington's law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist

What is the full name of Sherrington's law?
Sherrington's law of…***reciprocal innervation***

Q

Sherrington's Law vs Hering's Law



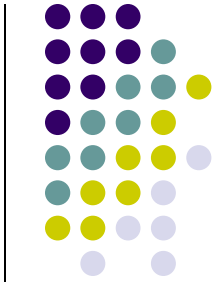
- Define **Sherrington's law** and **Hering's law**

  - **Sherrington's law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist

  - **Hering's law**: Innervation to [two words] is equal

A

Sherrington's Law vs Hering's Law



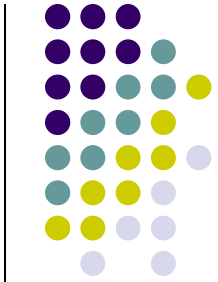
- Define **Sherrington's law** and **Hering's law**

  - **Sherrington's law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist

  - **Hering's law**: Innervation to yoke muscles is equal

Q

Sherrington's Law vs Hering's Law



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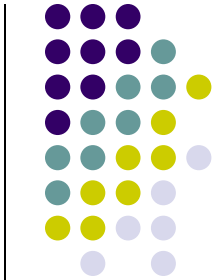
What is the full name of Hering's law?
Hering's law of…

A

Sherrington's Law vs Hering's Law



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What is the full name of Hering's law?
Hering's law of…***motor correspondence***

Q

Sherrington's Law vs Hering's Law

- Define **Sherrington's law** and **Hering's law**
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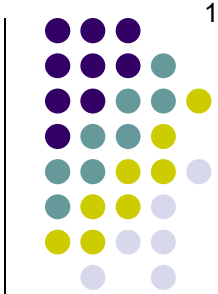
  - **Hering's law**: Innervation to **yoke muscles** is equal

To what does the term yoke muscles *refer?*

A

Sherrington's Law vs Hering's Law



- Define **Sherrington's law** and **Hering's law**
  - **Sherrington's law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist
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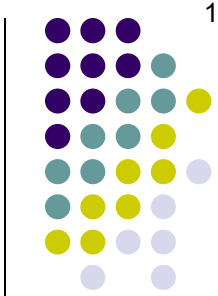
To what does the term yoke muscles *refer?*
It refers to the two muscles—one for each eye—that are responsible for putting the eyes into a given position of gaze

Q

Sherrington's Law vs Hering's Law



- Define **Sherrington's law** and **Hering's law**
  - **Sherrington's law**: Increased innervation to a
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Speaking of positions of gaze…How many positions are used in evaluating ocular motility and alignment?

n to **yoke muscles** is equal

To what does the term yoke muscles *refer?*
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Sherrington's Law vs Hering's Law

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Q

Sherrington's Law vs Hering's Law

- Define **Sherrington's law** and **Hering's law**
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Speaking of positions of gaze…How many positions are used in evaluating ocular motility and alignment?
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The nine positions are divided into three groups—what are they?
--
--
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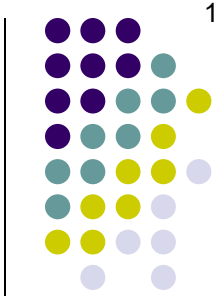
Sherrington's Law vs Hering's Law



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Q

Sherrington's Law vs Hering's Law

- Define **Sherrington's law** and **Hering's law**
  - **Sherrington's law**: Increased innervation to a
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OK, I know what primary gaze is, and 'up and down' seem obvious. But as for the so-called cardinal positions…First, how many 'cardinal positions' are there?

Speaki
are use
Nine

The nin
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Q/A

Sherrington's Law vs Hering's Law

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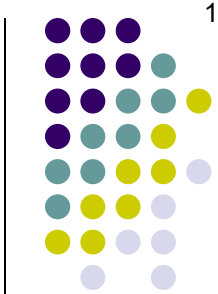
A

Sherrington's Law vs Hering's Law



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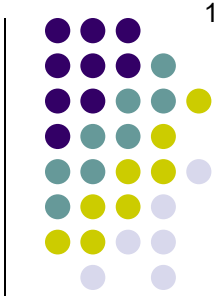
A

Sherrington's Law vs Hering's Law



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    There's one primary gaze (duh)…

    n to **yoke muscles** is equal

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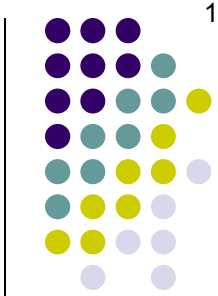
Sherrington's Law vs Hering's Law



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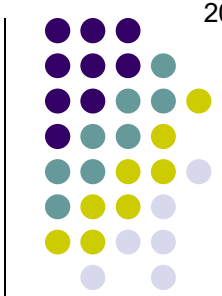
Sherrington's Law vs Hering's Law



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    n to **yoke muscles** is equal

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Q

Sherrington's Law vs Hering's Law

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What is a cardinal position*s* of gaze*?*

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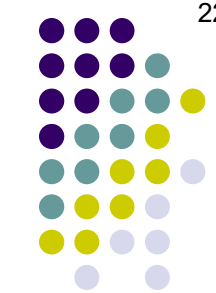
A

Sherrington's Law vs Hering's Law



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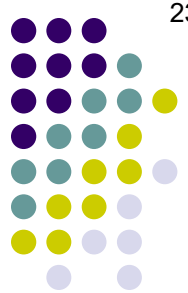
What is a cardinal position*s* of gaze*?*
One that corresponds to the field of action for a given EOM

To what does the term yoke muscles *refer?*
It refers to the two muscles—one for each eye—that are responsible for putting the eyes into a given **position of gaze**

Q

Sherrington's Law vs Hering's Law



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Ok. then what is a field of action*?*

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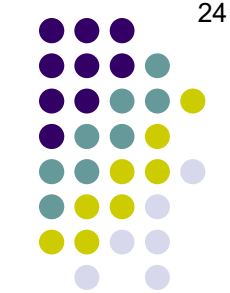
Sherrington's Law vs Hering's Law



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  - **Sherrington's law**: Increased innervation to a
    - *Speaki* … vation
      - *are use*
      - **Nine**
      - *The nin* … is equal
      - *what are they?*
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      - --Up and down (2)
      - *To what* …
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One

Ok. then what is a field of action*?*
It is a gaze direction in which the influence of a given EOM is mostly readily apparent. In essence, it's the position in which a given EOM 'cannot hide'—ie, the gaze direction in which a given muscle will be 'exposed' if it is not functioning properly.

Q

Sherrington's Law vs Hering's Law

?

- Defi aw
  - Sh a

Speaki *OK,* *the*
are use ation
Nine Well, we just said that "9" gaze positions are used in evaluating the EOMs. There's one primary gaze (duh)…plus 'up' and 'down' make three. This implies (correctly) ***What are the six cardinal positions of gaze?***.

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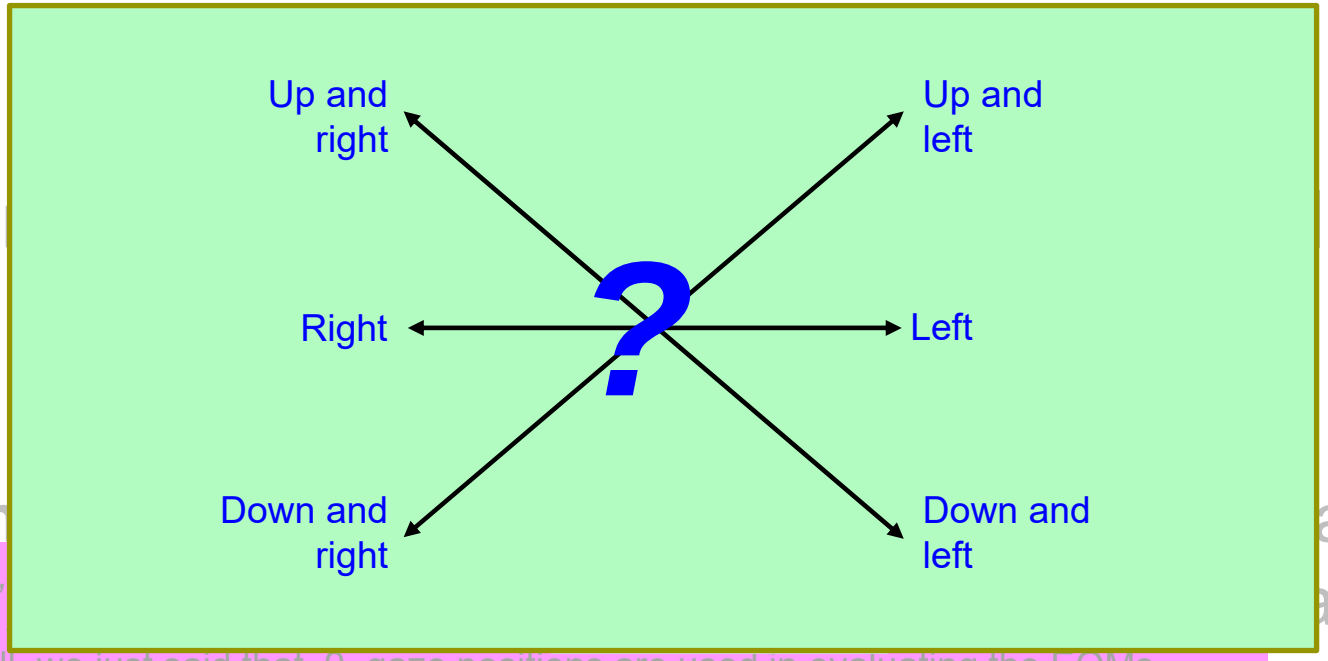
Sherrington's Law vs Hering's Law



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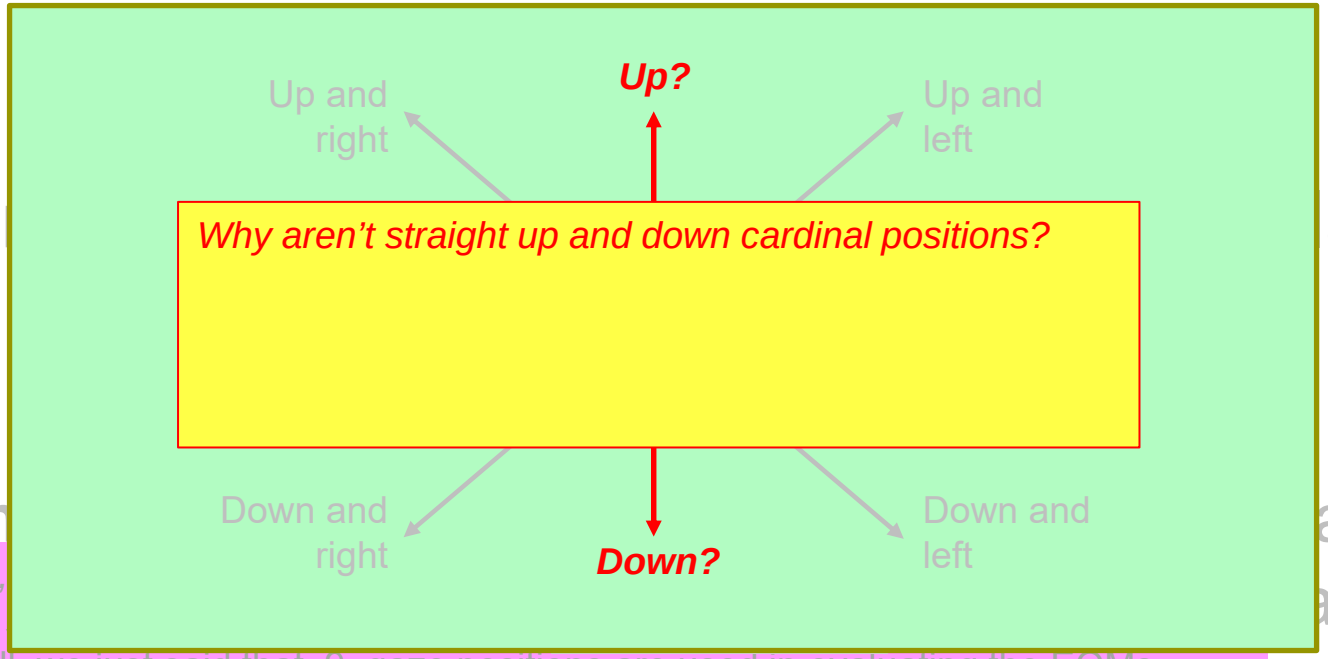

- Defi… …aw
  - Sh… …a

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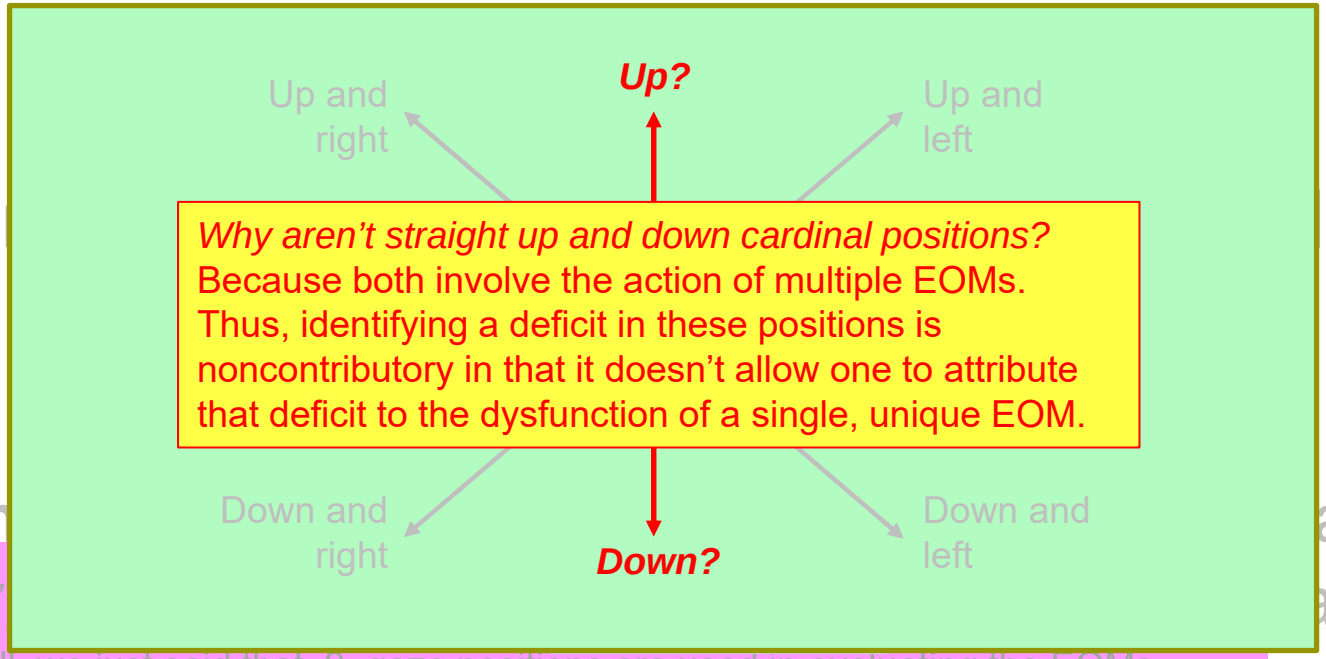

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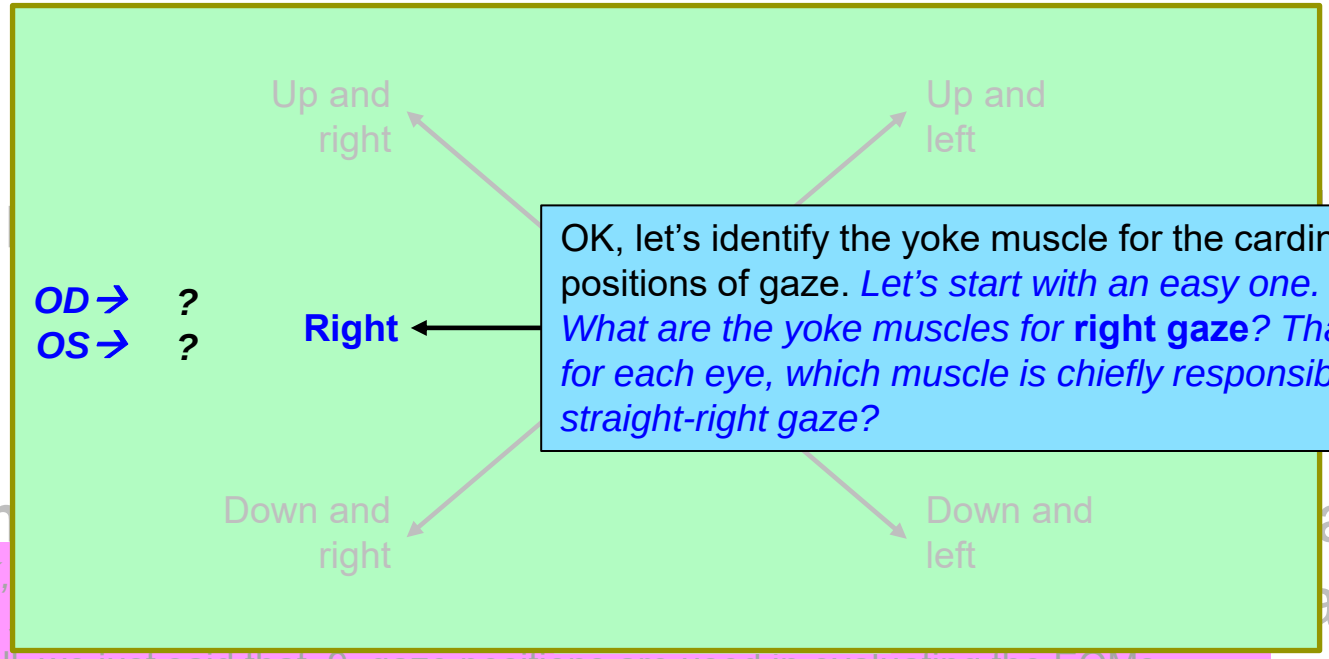

OK, let's identify the yoke muscle for the cardinal positions of gaze. *Let's start with an easy one. What are the yoke muscles for* **right gaze***? That is, for each eye, which muscle is chiefly responsible for straight-right gaze?*

- Defi

- Sh

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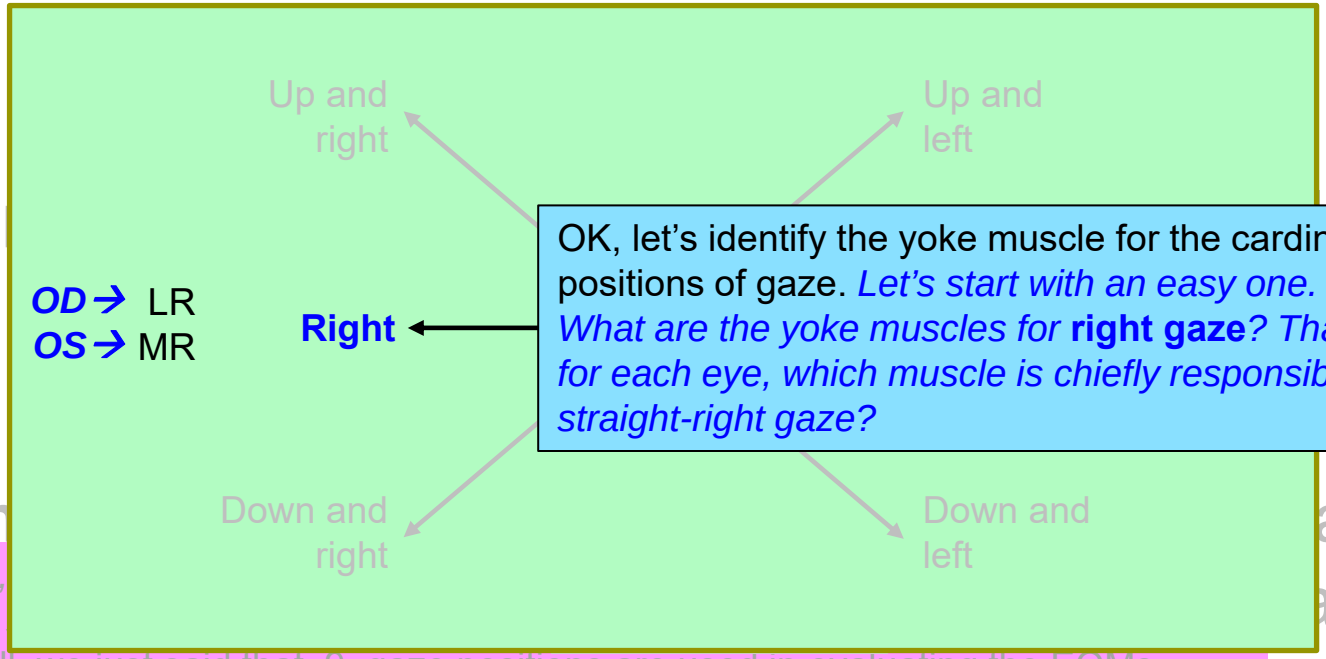

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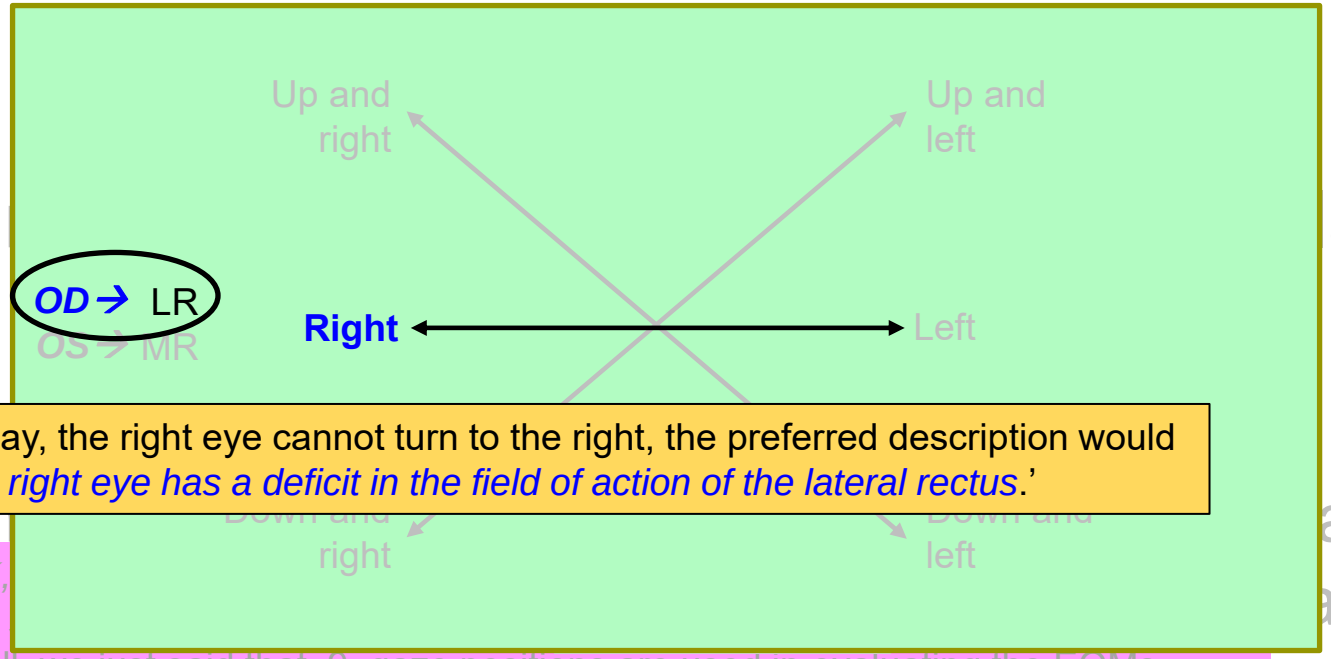
Sherrington's Law vs Hering's Law



So if, say, the right eye cannot turn to the right, the preferred description would be '*the right eye has a deficit in the field of action of the lateral rectus*.'

- Defi aw
- Sh a

Speaki ation
are use
Nine

The nin
what are they?
--Primary position (1)
--Cardinal positions (6)
--Up and down (2)

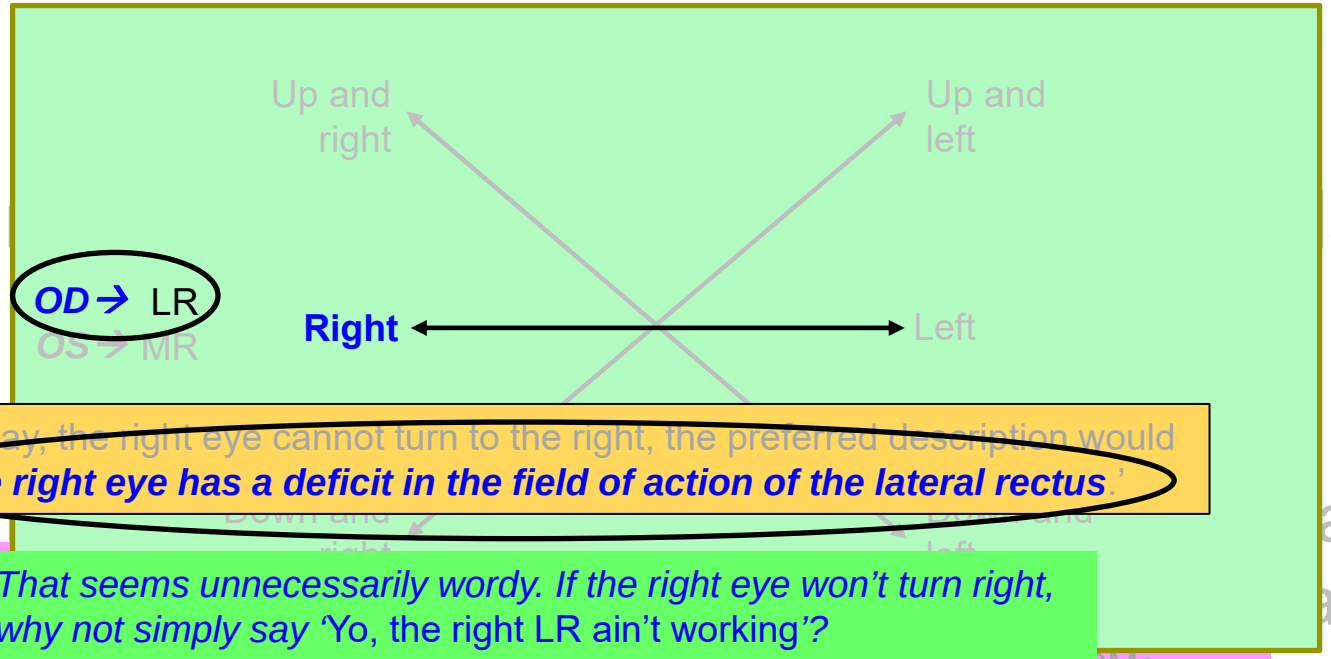
OK, *the*
Well, we just said that 9 gaze positions are used in evaluating the EOMs. There's one primary gaze (duh)…plus 'up' and 'down' make three. This implies (correctly) that ***what are the six cardinal positions of gaze?***.

n to **yoke muscles** is equal

To what does the term yoke muscles *refer?*
It refers to the two muscles—one for each eye—that are responsible for putting the eyes into a given position of gaze

Q

Sherrington's Law vs Hering's Law



So if, say, the right eye cannot turn to the right, the preferred description would be '***the right eye has a deficit in the field of action of the lateral rectus***.'

That seems unnecessarily wordy. If the right eye won't turn right, why not simply say 'Yo, the right LR ain't working'*?*

Nine

--Primary position (1)
--Cardinal positions (6)
--Up and down (2)

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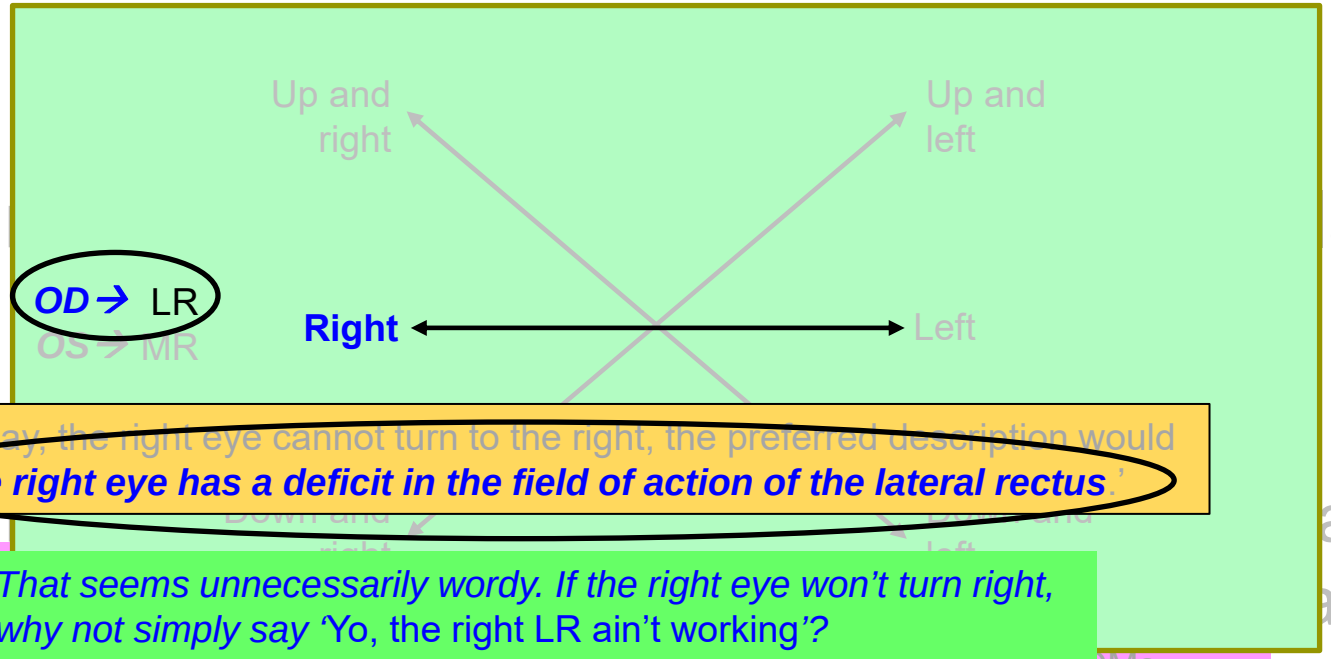
A

Sherrington's Law vs Hering's Law



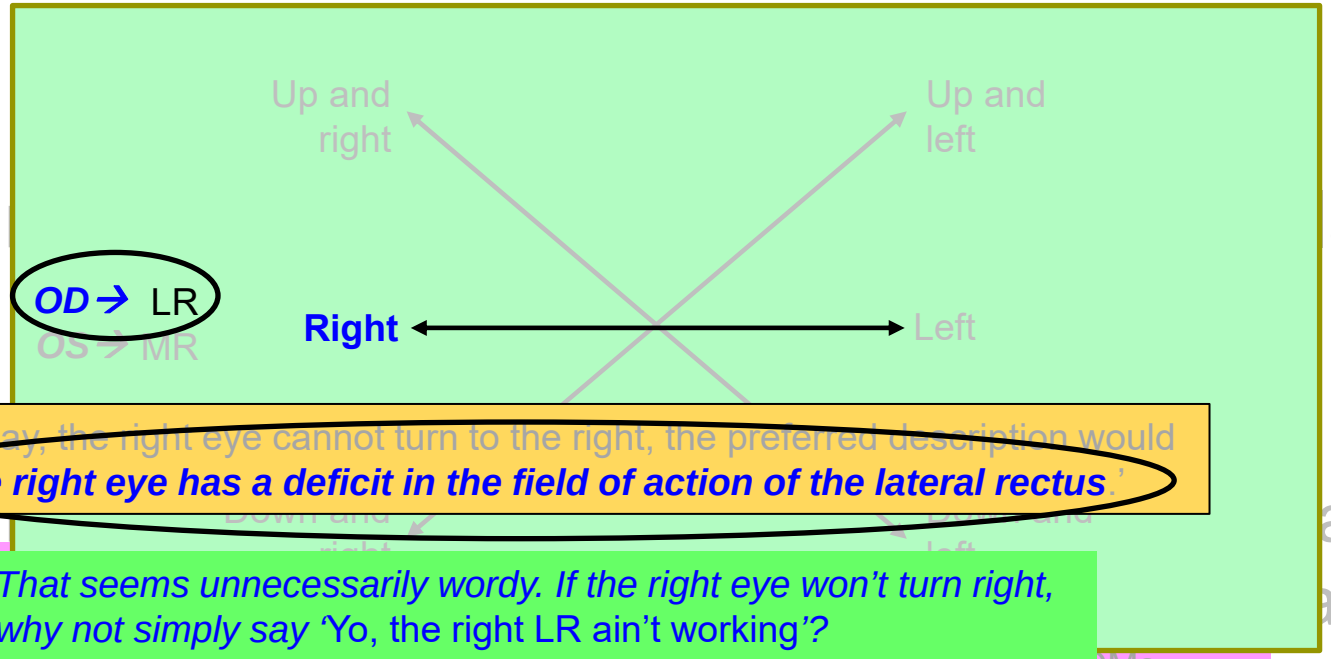
So if, say, the right eye cannot turn to the right, the preferred description would be '***the right eye has a deficit in the field of action of the lateral rectus***.'

That seems unnecessarily wordy. If the right eye won't turn right, why not simply say 'Yo, the right LR ain't working'?
Because an inability of the right eye to ABduct is not necessarily indicative of LR dysfunction.

To what does the term yoke muscles *refer?*
It refers to the two muscles—one for each eye—that are responsible for putting the eyes into a given position of gaze

A

Sherrington's Law vs Hering's Law



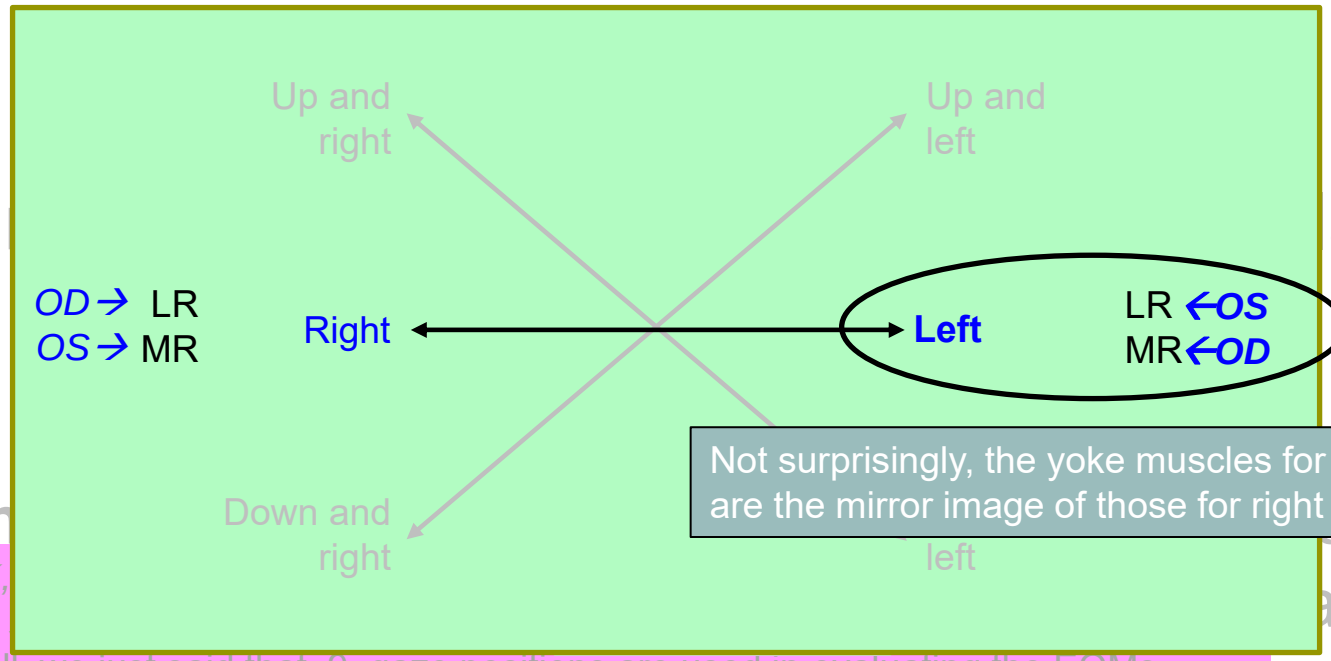
So if, say, the right eye cannot turn to the right, the preferred description would be '***the right eye has a deficit in the field of action of the lateral rectus***.'

That seems unnecessarily wordy. If the right eye won't turn right, why not simply say 'Yo, the right LR ain't working'?
Because an inability of the right eye to ABduct is not necessarily indicative of LR dysfunction. For example, LR function might be fully intact, but a medial restrictive process—say, entrapment of the MR in a healed medial-wall fracture—could be present.

--Primary position (1)
--Cardinal positions (6)
--Up and down (2)

To what does the term yoke muscles *refer?*
It refers to the two muscles—one for each eye—that are responsible for putting the eyes into a given position of gaze

Sherrington's Law vs Hering's Law



Not surprisingly, the yoke muscles for ***left*** gaze are the mirror image of those for right gaze

- Defi aw
  - Sh

Speaki
are use
Nine

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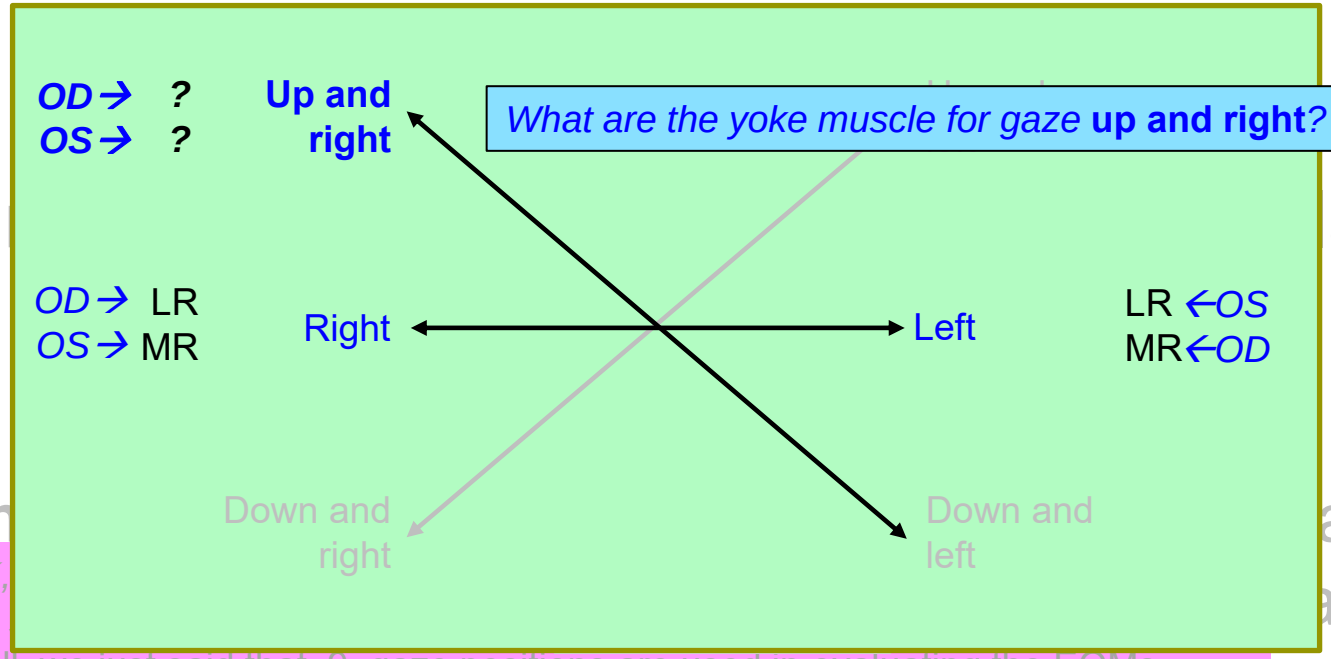
Q

Sherrington's Law vs Hering's Law



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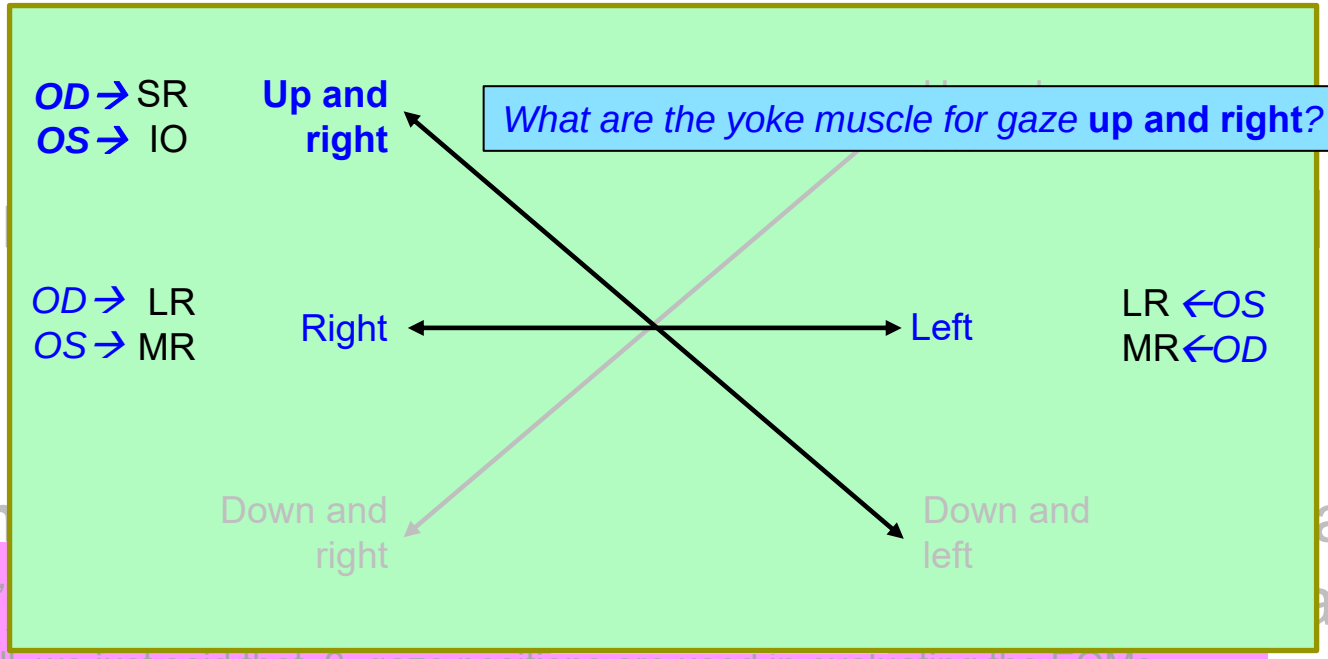
Sherrington's Law vs Hering's Law



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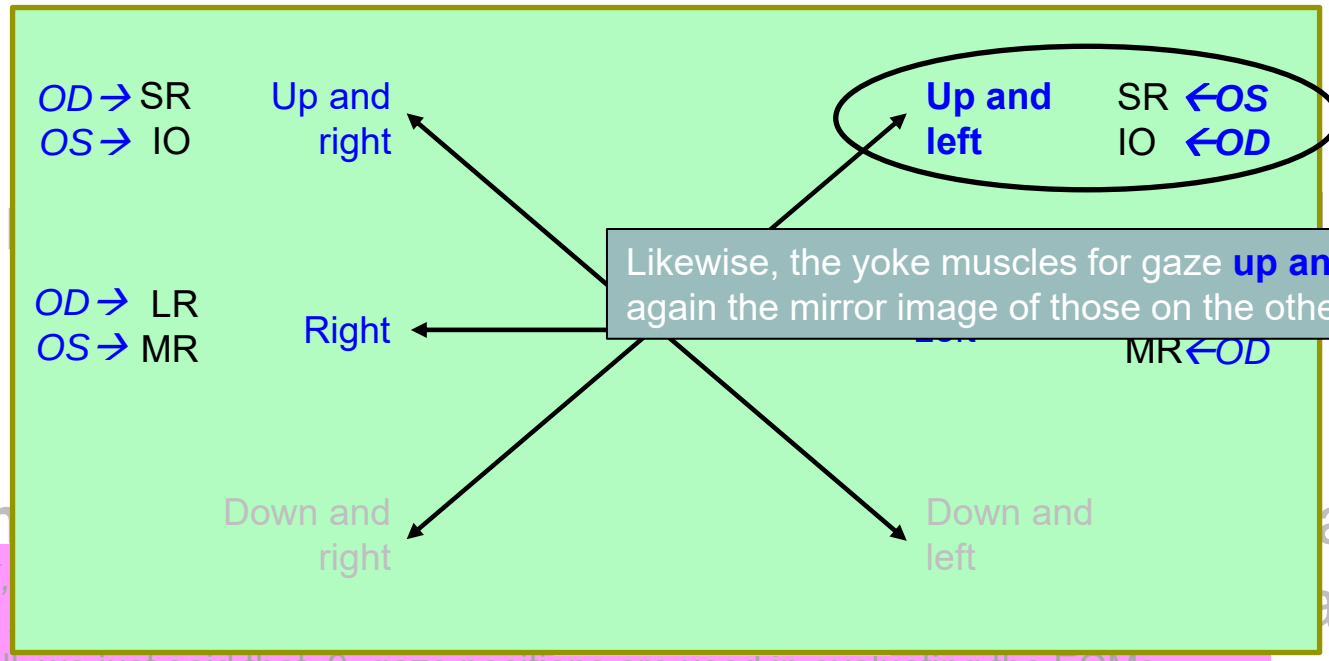
Sherrington's Law vs Hering's Law



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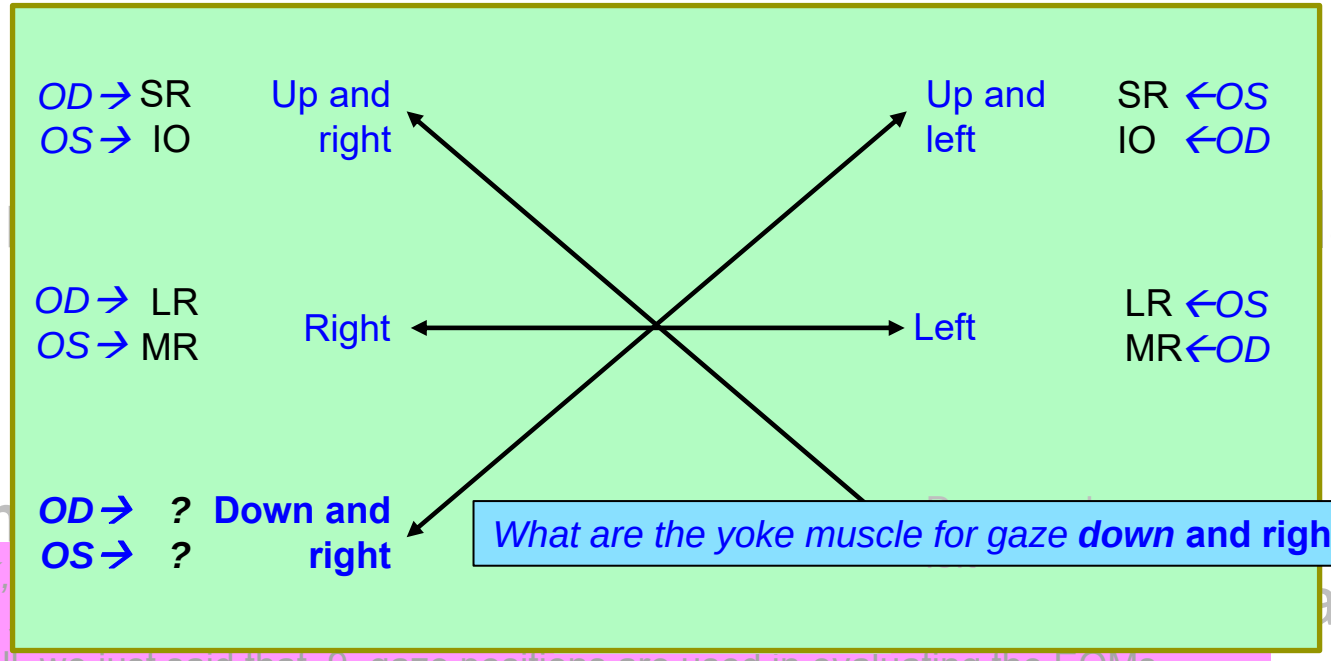
Sherrington's Law vs Hering's Law



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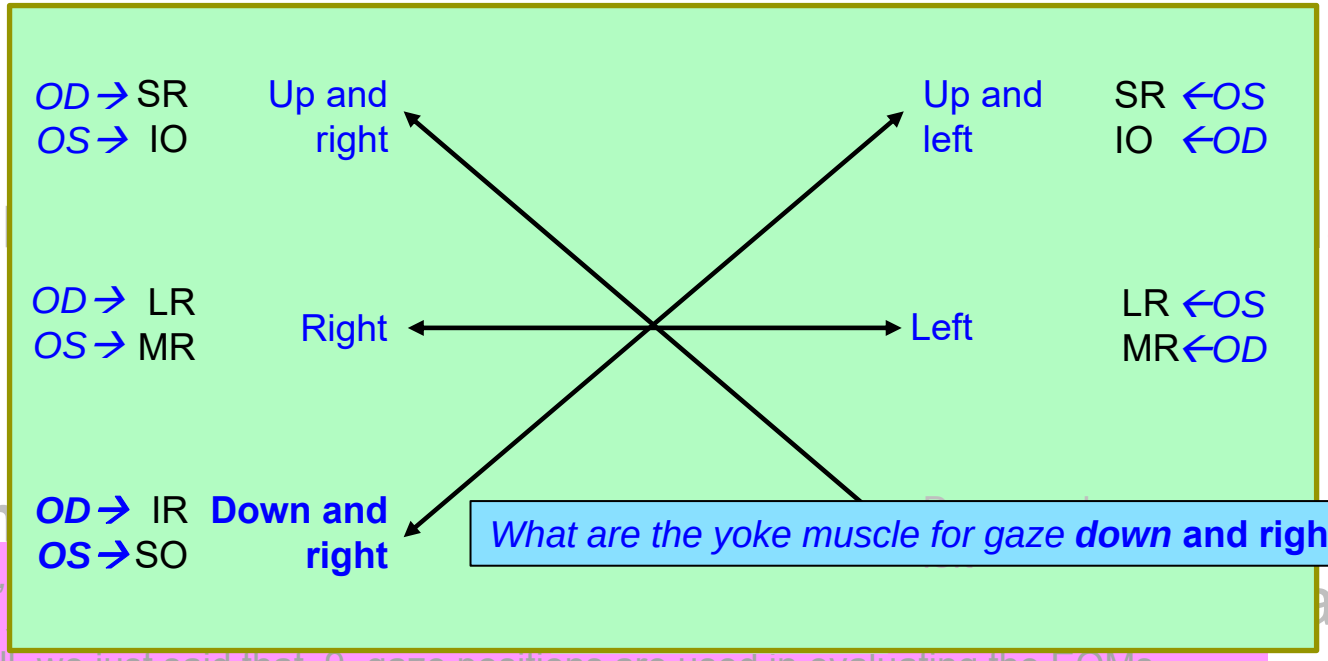
Sherrington's Law vs Hering's Law



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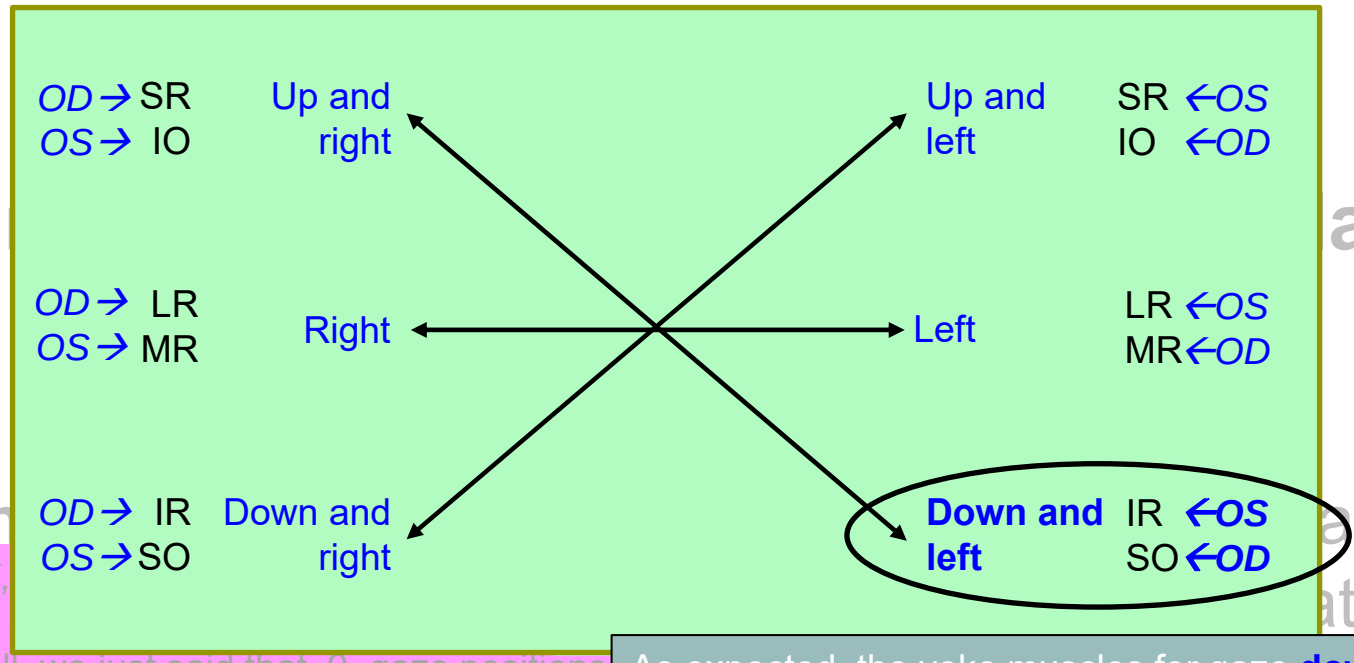
Sherrington's Law vs Hering's Law



As expected, the yoke muscles for gaze **down and *left*** are the mirror image of those on the other side

- Defi… …aw
  - Sh… …a

Speaki… …ation
are use…
Nine

The nin…
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--Primary position (1)
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OK, *the*
Well, we just said that 9 gaze positions…
There's one primary gaze (duh)…plus 'u…
(correctly) ***What are the six cardinal positions of gaze?***

…n to **yoke muscles** is equal

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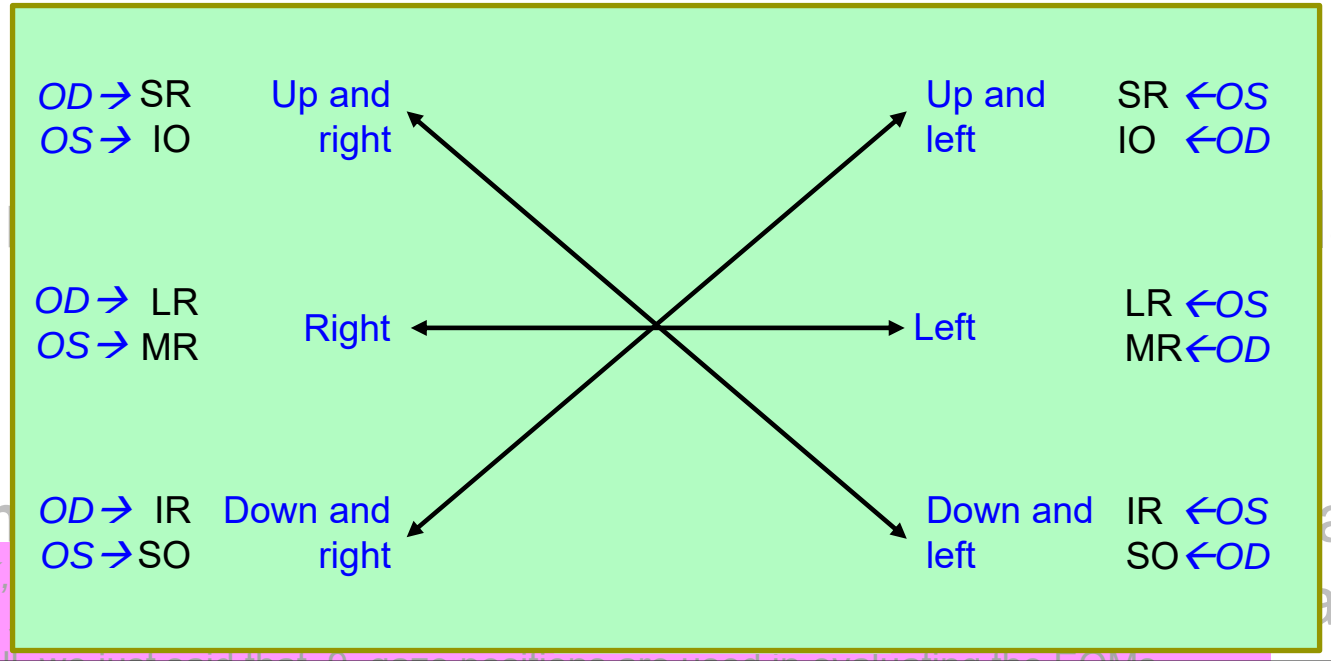
Sherrington's Law vs Hering's Law



- Defi… …aw
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Speaki… OK, … …ation
are use… the …

--Primary position (1)
--Cardinal positions (6)
--Up and down (2)

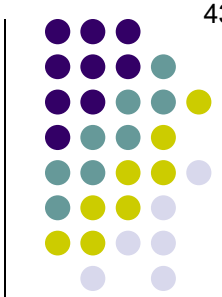
…n to **yoke muscles** is equal

The cardinal positions of gaze, and the yoke muscles for each
(summary slide—proceed when ready)

To what does the term yoke muscles *refer?*
It refers to the two muscles—one for each eye—that are responsible for putting the eyes into a given position of gaze

Q

Sherrington's Law vs Hering's Law

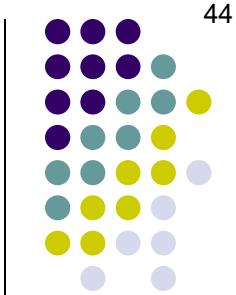


- Define **Sherrington's law** and **Hering's law**
  - **Sherrington's law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist
  - **Hering's law**: In

Speaking of Hering's law…What determines the total amount of innervational input the eyes receive?

A

Sherrington's Law vs Hering's Law



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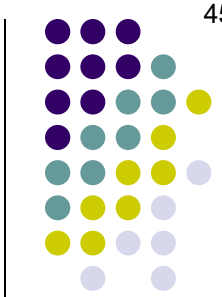
It is determined by the amount of innervation needed for the fixating eye to get into and maintain position

Q

Sherrington's Law vs Hering's Law



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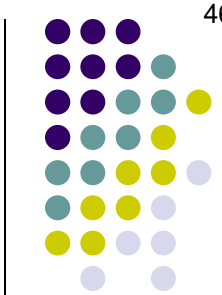
OK, but both eyes are pointing at the same thing. Why would it matter which is fixating?

A

Sherrington's Law vs Hering's Law



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OK, but both eyes are pointing at the same thing. Why would it matter which is fixating?
When the oculomotor control system is intact, it doesn't. But when one eye has a paretic muscle, which eye is fixating has an enormous effect on the amount of innervational input.

Sherrington's Law vs Hering's Law

Consider a pt with a paretic right lateral rectus (RLR).

No question for the next several slides—read, then proceed

law and **Hering's law**

reased innervation to a muscle is accompanied by **decreased** innervation to its antagonist

- **Hering's law**: In

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Sherrington's Law vs Hering's Law

Consider a pt with a paretic right lateral rectus (RLR). As expected, his muscle balance is ET. What happens when he looks at an object to his right? If he fixates with his intact left eye, a normal, moderate amount of innervational input to the left medial rectus (LMR) is all that is required to get this eye into right gaze. And by Hering's law, an equivalent moderate amount of innervation will be sent to the RLR.

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law and Hering's law

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Speaking of Hering's law…What determines the total amount of innervational input the eyes receive?
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Next consider what happens if the pt fixates the same object of regard to his right, but this time with the paretic right eye. To get the paretic RLR to contract enough to cause the eye to ABduct, our pt must crank in a massive amount of innervational input.

muscle is accompanied by decreased innervation to its antagonist

- **Hering's law**: In

Speaking of Hering's law…What determines the total amount of innervational input the eyes receive?
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Next consider what happens if the pt fixates the same object of regard to his right, but this time with the paretic right eye. To get the paretic RLR to contract enough to cause the eye to ABduct, our pt must crank in a massive amount of innervational input. By Hering's law, we know the same (massive) amount of innervation will be sent to the (intact) LMR, causing this eye to way over-ADduct, thereby producing a **large** increase in the measured ET.

muscle is accompanied by decreased innervation to its antagonist

- **Hering's law**: In

Speaking of Hering's law…What determines the total amount of innervational input the eyes receive?
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OK, but both eyes are pointing at the same thing. Why would it matter which is fixating?
When the oculomotor control system is intact, it doesn't. But when one eye has a paretic muscle, **which eye is fixating has an enormous effect on the amount of innervational input.**

Q

Sherrington's Law vs Hering's Law

Consider a pt with a paretic right lateral rectus (RLR). As expected, his muscle balance is ET. What happens when he looks at an object to his right? **If he fixates with his intact left eye**, a normal, moderate amount of innervational input to the left medial rectus (LMR) is all that is required to get this eye to right gaze. And by Hering's law, an equivalent moderate amount of innervation will be sent to the RLR. Even though it is paretic, the moderate innervational input it receives will not produce much abduction, and the measured ET will increase only modestly.

Next consider what happens if the pt fixates the same object of regard to his right, but this time with the paretic right eye. To get the paretic RLR to contract enough to abduct the eye, our pt must crank in a massive amount of innervational input. By Hering's law, we know the same (massive) amount of innervation will be sent to the (intact) LMR, causing this eye to way over-adduct, thereby producing a **large** increase in the measured ET.

The amount of strabismus present while the pt fixates with the nonparetic eye is called the _____ deviation.

Hering's law: Ir

innervational input the eyes receive?

It is determined by the amount of innervation needed for the fixating eye to get into and maintain position

OK, but both eyes are pointing at the same thing. Why would it matter which is fixating?

When the oculomotor control system is intact, it doesn't. But when one eye has a paretic muscle, **which eye is fixating has an enormous effect on the amount of innervational input.**

A

Sherrington's Law vs Hering's Law

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The amount of strabismus present while the pt fixates with the nonparetic eye is called the *primary* deviation.

- **Hering's law**: Ir

innervational input the eyes receive?

It is determined by the amount of innervation needed for the fixating eye to get into and maintain position

OK, but both eyes are pointing at the same thing. Why would it matter which is fixating?

When the oculomotor control system is intact, it doesn't. But when one eye has a paretic muscle, **which eye is fixating has an enormous effect on the amount of innervational input.**

OD fixating (= **primary** deviation)

Pt with left LR palsy

Q

Sherrington's Law vs Hering's Law

Consider a pt with a paretic right lateral rectus (RLR). As expected, his muscle balance is ET. What happens when f he looks at an object to his right? If he fixates with his intact left eye, a normal, moderate amount of innervational input to the left medial rectus (LMR) is all that is required to get this eye into right gaze. And by Hering's law, an equivalent moderate amount of innervation will be sent to the RLR. Given that it is paretic, the moderate innervational input it receives will not produce much abduction, and the measured ET will increase only modestly.

Next consider what happens if the pt fixates the same object of regard to his right, but this time **with the paretic right eye**. To get the paretic RLR to contract enough to abduct the eye, our pt must crank in a massive amount of innervational input. By Hering's law we know the same (massive) amount of innervation will be sent to the (intact) LMR, causing this eye to way over-adduct, thereby producing a **large** increase in the measured ET.

The amount present while the pt fixates with the paretic eye is called the deviation.

- **Hering's law**: Ir

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A

Sherrington's Law vs Hering's Law

Consider a pt with a paretic right lateral rectus (RLR). As expected, his muscle balance is ET. What happens when he looks at an object to his right? If he fixates with his intact left eye, a normal, moderate amount of innervational input to the left medial rectus (LMR) is all that is required to get this eye into right gaze. And by Hering's law, an equivalent moderate amount of innervation will be sent to the RLR. Given that it is paretic, the moderate innervational input it receives will not produce much abduction, and the measured ET will increase only modestly.

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The amount present while the pt fixates with the paretic eye is called the *secondary* deviation.

- **Hering's law**: Ir

innervational input the eyes receive?

It is determined by the amount of innervation needed for the fixating eye to get into and maintain position

OK, but both eyes are pointing at the same thing. Why would it matter which is fixating?

When the oculomotor control system is intact, it doesn't. But when one eye has a paretic muscle, **which eye is fixating has an enormous effect on the amount of innervational input.**

OS fixating (= **secondary** deviation)

Pt with left LR palsy

Sherrington's Law vs Hering's Law

Consider a pt with a paretic right lateral rectus (RLR). As expected, his muscle balance is ET. What happens when he looks at an object to his right? If he fixates with his intact left eye, a normal, moderate amount of innervational input to the left medial rectus (LMR) is all that is required to get this eye into right gaze. And by Hering's law, an equivalent moderate amount of innervation will be sent to the RLR. Given that it is paretic, the moderate innervational input it receives will not produce much abduction, and the measured ET will increase only modestly.

Next consider what happens if the pt fixates the same object of regard to his right, but this time with the paretic right eye. To get the paretic RLR to contract enough to abduct the eye, our pt must crank in a massive amount of innervational input. By Hering's law, we know the same (massive) amount of innervation will be sent to the (intact) LMR, causing this eye to way over-adduct, thereby producing a **large** increase in the measured ET.

The amount of strabismus present while the pt fixates with the nonparetic eye is called the *primary* deviation. The amount present while the pt fixates with the paretic eye is called the *secondary* deviation. ***Hering's law is the reason these measurements are not identical, and why the secondary deviation is always larger.***

- **Hering's law**:

innervational input the eyes receive?

It is determined by the amount of innervation needed for the fixating eye to get into and maintain position

OK, but both eyes are pointing at the same thing. Why would it matter which is fixating?

When the oculomotor control system is intact, it doesn't. But when one eye has a paretic muscle, **which eye is fixating has an enormous effect on the amount of innervational input.**

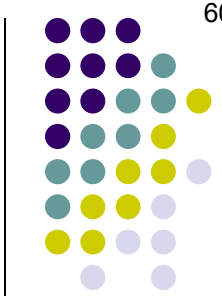
OD fixating (= **primary** deviation)

OS fixating (= **secondary** deviation)

Pt with left LR palsy (side-by-side for comparison purposes)

Q

Sherrington's Law vs Hering's Law

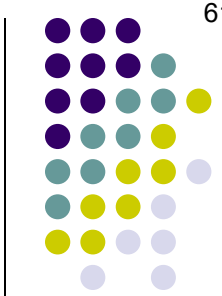


- Define **Sherrington's law** and **Hering's law**, and for each state the classic example of a strabismus-type in which it is violated:
  - **Sherrington's law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist
    - Violated in… strabismic condition (2 words)
  - **Hering's law**: Innervation to yoke muscles is equal

OK, now back to a question about Sherrington's law

A

Sherrington's Law vs Hering's Law



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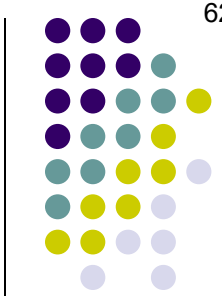

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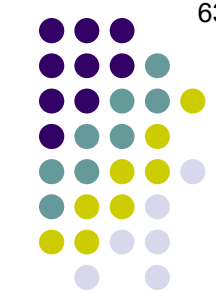
Briefly, what is Duane syndrome*?*

Q/A

Sherrington's Law vs Hering's Law



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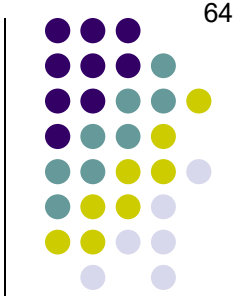
Briefly, what is Duane syndrome?
A motility disorder with the following key findings:
--At least some limitation of direction movement
-- Attempted movement causes the globe to one word, and may cause it to this or that movement

A

Sherrington's Law vs Hering's Law



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A motility disorder with the following key findings:
--At least some limitation of horizontal movement
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Horizontal movement limitation

Duane syndrome

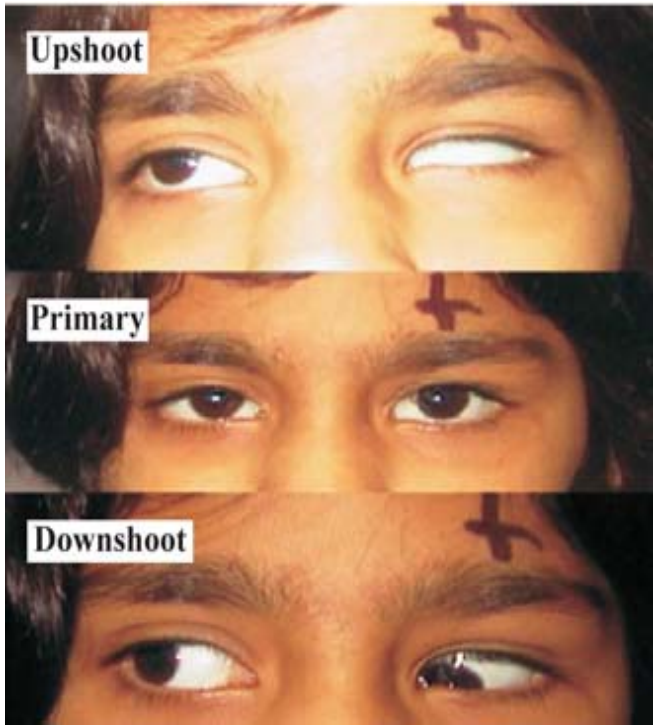
Horizontal movement limitation

Globe retraction

Duane syndrome

Horizontal movement limitation

Globe retraction

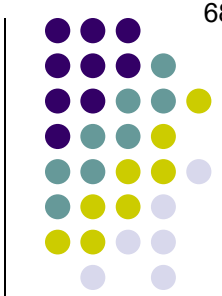


Upshoot/downshoot

Duane syndrome

Q

Sherrington's Law vs Hering's Law



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What is the cause?

Q/A

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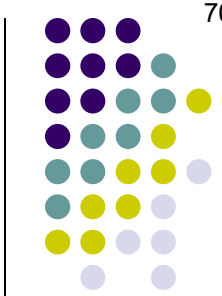

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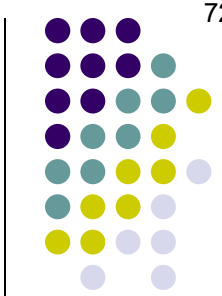

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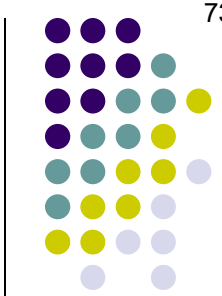

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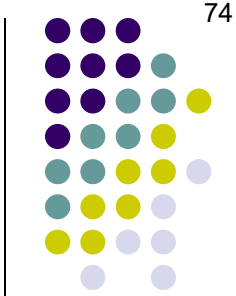

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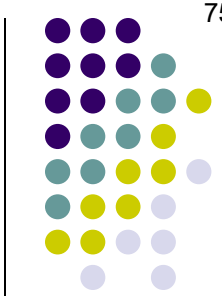

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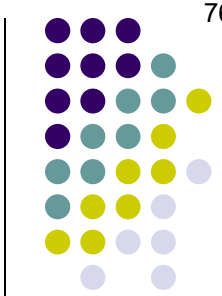
Q

Sherrington's Law vs Hering's Law



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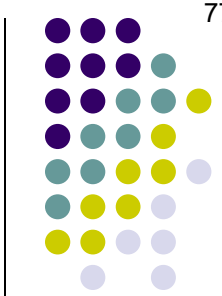

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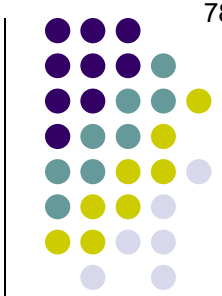

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Who is the typical DVD pt?

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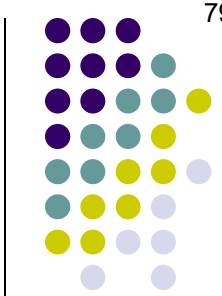
Sherrington's Law vs Hering's Law



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A child with infantile/congenital ET or XT

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      What is the classic clinical finding?
      An eye will slowly elevate and extort, either spontaneously (*manifest* DVD) or when occluded (*latent* DVD). A crucial finding occurs when the drifting eye reorients downward, and it is this--the fellow eye does not move downward simultaneously (as would normally be the case).
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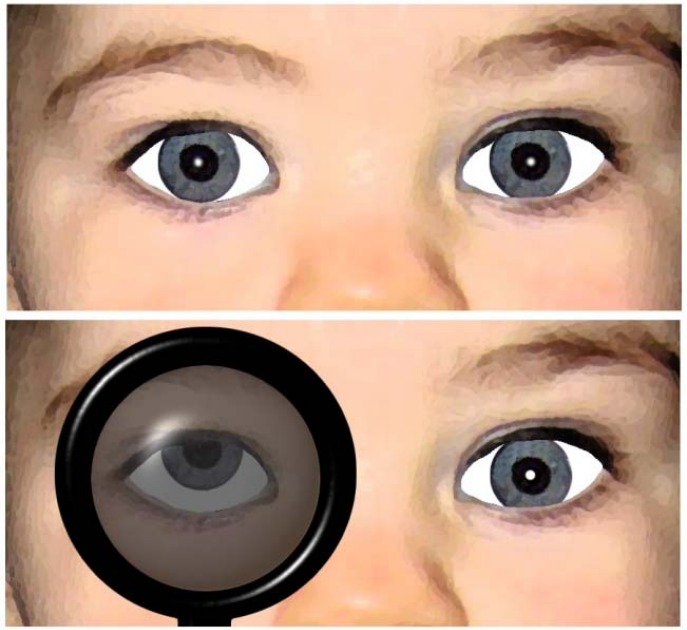

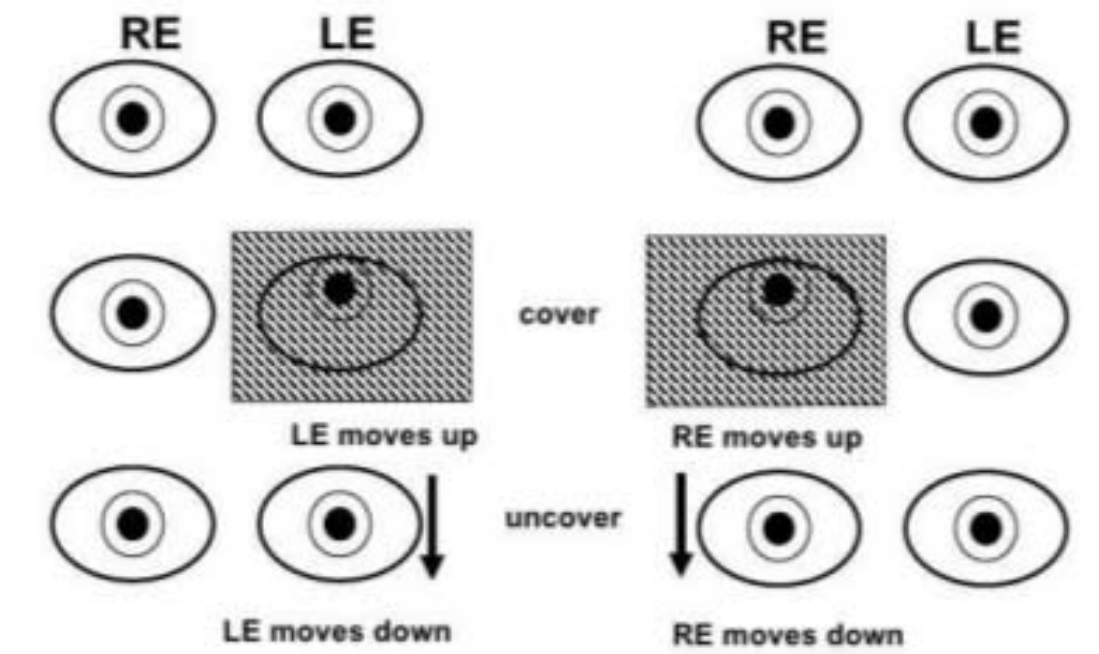
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LE moves up
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uncover
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DVD

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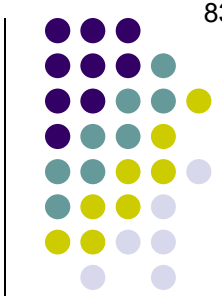

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    - *How does Hering's law relate to DVD?*
  - **Hering's law**: Innervation to yoke muscles is equal
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Sherrington's Law vs Hering's Law

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      How does Hering's law relate to DVD?
      As noted, in DVD the downward reorientation movement by the drifting eye is not accompanied by a downward movement of the fellow eye. As the muscles that depress the eyes are yoke muscles, this means that DVD represents a violation of Hering's law.
  - **Hering's law**: Innervation to yoke muscles is equal
    - Violated in... **dissociated vertical deviation (DVD)**