Define **Sherrington’s law**

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

Sherrington’s law: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist.
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...
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
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
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
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.

What is the full name of Hering’s law?
Hering’s law of...
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.

*What is the full name of Hering’s law? Hering’s law of…*motor correspondence*
Define Sherrington’s law and Hering’s law

- **Sherrington’s law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist. Violated in Duane syndrome.

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

*To what does the term yoke muscles refer?*
Define Sherrington’s law and Hering’s law.

- **Sherrington’s law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist. Violated in Duane syndrome.

- **Hering’s law**: Innervation 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.
Define Sherrington’s law and Hering’s law.

Sherrington’s law: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist. Violated in Duane syndrome.

Hering’s law: Innervation to yoke muscles is equal.

Speaking of positions of gaze…How many positions are used in evaluating ocular motility and alignment?

Nine

The nine positions are divided into three groups—

- Primary position
- Cardinal positions
- Up and down

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.
Define Sherrington’s law and Hering’s law.

Sherrington’s law: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist. Violated in Duane syndrome.

Hering’s law: Innervation to yoke muscles is equal.

Speaking of positions of gaze…How many positions are used in evaluating ocular motility and alignment? Nine.

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.
Define **Sherrington’s law** and **Hering’s law**.

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

Violated in Duane syndrome.

**Hering’s law**: Innervation to yoke muscles is equal.

---

**Speaking of positions of gaze**…How many positions are used in evaluating ocular motility and alignment?

Nine

*The nine positions are divided into three groups—what are they?*

---

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

● Define Sherrington’s Law and Hering’s Law

Sherrington’s Law: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist.

Violated in Duane syndrome.

Hering’s Law: Innervation to yoke muscles is equal.

Speaking of positions of gaze…How many positions are used in evaluating ocular motility and alignment?
Nine

The nine positions are divided into three groups—what are they?
--Primary position
--Cardinal positions
--Up and down

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.
Define Sherrington’s law and Hering’s law.

- **Sherrington’s law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist. Violated in... Duane syndrome.

- **Hering’s law**: Innervation 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.
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. Violated in Duane syndrome.

Hering’s law: Innervation to yoke muscles is equal.

Speaking of positions of gaze... How many positions are used in evaluating ocular motility and alignment?

Nine.

The nine what are they?
--Primary position
--Cardinal positions
--Up and down

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? Well, we just said that nine gaze positions are used in evaluating the EOMs. This implies (correctly) that there are six cardinal positions of gaze.

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.
Define Sherrington’s law and Hering’s law.

- **Sherrington’s law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist.
  - Violated in Duane syndrome.

- **Hering’s law**: Innervation to yoke muscles is equal.
  - The nine positions are divided into:
    - Primary position
    - Cardinal positions
    - Up and down
  - 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? Well, we just said that 9 gaze positions are used in evaluating the EOMs. This implies (correctly) that there are six cardinal positions of gaze.
  - 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.
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 Duane syndrome.

- **Hering's law**: Innervation 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.

Speaking of positions of gaze... How many positions are used in evaluating ocular motility and alignment? Nine. The nine positions are divided into three groups—what are they?

---

**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.

---

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.

---

The nine positions are divided into three groups—what are they?

- **Primary position (1)**
- **Cardinal positions**
- **Up and down**

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? Well, we just said that 9 gaze positions are used in evaluating the EOMs. There's one primary gaze (duh)...
Define Sherrington’s law and Hering’s law.

- **Sherrington’s law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist.
  - Violated in Duane syndrome.

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

**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? 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.

**Nine**

- Primary position (1)
- Cardinal positions
- 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.
Define Sherrington’s law and Hering’s law.

- **Sherrington’s law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist. Violated in Duane syndrome.

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

Speaking of positions of gaze... How many positions are used in evaluating ocular motility and alignment? Nine.

The nine positions are divided into three groups—what are they?

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

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? 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 there are six cardinal positions of gaze.

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.
- Define **Sherrington’s law** and **Hering’s law**

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

Violated in... **Duane syndrome**

**Hering’s law**: Innervation 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.

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

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? 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 there are six cardinal positions...
Define Sherrington’s law and Hering’s law

- **Sherrington’s law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist. Violated in Duane syndrome.
- **Hering’s law**: Innervation to yoke muscles is equal.

Nine positions are used in evaluating ocular motility and alignment:
- Primary position (1)
- Cardinal positions (6)
- Up and down (2)

**What is a cardinal positions 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.
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.

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 Duane syndrome*

**Hering’s law**: Innervation to yoke muscles is equal.

Speaking of positions of gaze... How many positions are used in evaluating ocular motility and alignment?

Nine

The nine positions are divided into three groups—what are they?

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

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? 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 there are six cardinal positions of gaze?

One

What is a cardinal positions of gaze?

Ok, then what is a field of action?

It refers to the two muscles—one for each eye—that are responsible for putting the eyes into a given position of gaze.
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**

- **Sherrington’s law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist.
  - Violated in Duane syndrome.
- **Hering’s law**: Innervation to yoke muscles is equal.

**Speaking of positions of gaze…**

- **Nine** gaze positions are used in evaluating the EOMs.
- There’s one primary gaze (duh)...plus ‘up’ and ‘down’ make three. This implies (correctly) that there are six cardinal positions of gaze.

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

- 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.
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 Duane syndrome.

Hering’s law: Innervation 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.

Speaking of positions of gaze…How many positions are used in evaluating ocular motility and alignment? Nine. The nine positions are divided into three groups—

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

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? 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 there are six cardinal positions of gaze. What are they?
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 Duane syndrome.

Hering’s law: Innervation to yoke muscles is equal.

Speaking of positions of gaze... How many positions are used in evaluating ocular motility and alignment?
- Nine

The nine positions are divided into three groups—what are they?
- Primary position (1)
- Cardinal positions (6)
- Up and down (2)

Right
- Down and right
- Up and left

Left
- Down and left
- Up and right

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?
- 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 there are six cardinal positions of gaze?

What are the six cardinal positions of gaze?

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.
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 Duane syndrome.

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

**Speaking of positions of gaze…**

How many positions are used in evaluating ocular motility and alignment?

Nine.

The nine positions are divided into three groups—what are they?

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

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? 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 there are six cardinal positions of gaze?

Why aren’t straight up and down cardinal positions?

Both involve input from multiple EOMs. Because of this, identifying a deficit in these positions is noncontributory in that it doesn’t allow one to attribute that deficit to the dysfunction of a single, unique 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.
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 Duane syndrome.

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

Speaking of positions of gaze... How many positions are used in evaluating ocular motility and alignment?

Nine

The nine positions are divided into three groups—

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

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?

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 there are six cardinal positions of gaze.

Why aren't straight up and down cardinal positions? Because both involve the action of multiple EOMs. Thus, identifying a deficit in these positions is noncontributory in that it doesn't allow one to attribute that deficit to the dysfunction of a single, unique EOM.

What are the six cardinal positions of gaze?

- Up and right
- Up and left
- Down and right
- Down and left

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.
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 Duane syndrome.

- **Hering’s law**: Innervation 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.
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 Duane syndrome.

- **Hering's law**: Innervation 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.

Sherrington's Law vs Hering's Law

Speaking of positions of gaze... How many positions are used in evaluating ocular motility and alignment?

Nine

The nine are divided into three groups—what are they?
--Primary position (1)
--Cardinal positions (6)
--Up and down (2)

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?
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 Duane syndrome.

- **Hering’s law**: Innervation 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.

Sherrington’s Law vs Hering’s Law

Speaking of positions of gaze…How many positions are used in evaluating ocular motility and alignment?

- Nine

The nine positions are divided into three groups—what are they?

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

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?

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 there are six cardinal positions of gaze?

<table>
<thead>
<tr>
<th>Right</th>
<th>Left</th>
</tr>
</thead>
<tbody>
<tr>
<td>OD → LR</td>
<td></td>
</tr>
<tr>
<td>OD → MR</td>
<td></td>
</tr>
<tr>
<td>OS → LR</td>
<td></td>
</tr>
<tr>
<td>OS → MR</td>
<td></td>
</tr>
<tr>
<td>Down and right</td>
<td></td>
</tr>
<tr>
<td>Down and left</td>
<td></td>
</tr>
</tbody>
</table>

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.*
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 Duane syndrome.

- **Hering's law**: Innervation 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.

Speaking of positions of gaze…How many positions are used in evaluating ocular motility and alignment?

Nine

The nine positions are divided into three groups—what are they?

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

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.
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 Duane syndrome.

**Hering's law**: Innervation 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.

Speaking of positions of gaze... How many positions are used in evaluating ocular motility and alignment? Nine. The nine positions are divided into three groups—what are they?

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

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.
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...Duane syndrome.

**Hering's law**: Innervation 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.

Speaking of positions of gaze...How many positions are used in evaluating ocular motility and alignment? Nine. The nine positions are divided into three groups—what are they?

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

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.
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 Duane syndrome.

- **Hering's law**: Innervation 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.

---

**Sherrington’s Law vs Hering’s Law**

![Diagram showing the relationship between Sherrington’s and Hering’s laws.](image)

- **Left**: LR → OS
- **Right**: OD → MR

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

*Speaking of positions of gaze…How many positions are used in evaluating ocular motility and alignment?*

**Nine**

The nine positions are divided into three groups—what are they?
- **Primary position (1)**
- **Cardinal positions (6)**
- **Up and down (2)**

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? 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 there are **six cardinal positions of gaze**.
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 Duane syndrome.

- **Hering’s law**: Innervation 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.
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 Duane syndrome.

- **Hering's law**: Innervation 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.

---

**Sherrington’s Law vs Hering’s Law**

- **OD** $\rightarrow$ **SR**
- **OS** $\rightarrow$ **IO**
- **OD** $\rightarrow$ **LR**
- **OS** $\rightarrow$ **MR**

- **Up and right**
- **Right**
- **Up and left**
- **Left**

*What are the yoke muscles for gaze up and right?*

- **OD** $\rightarrow$ **OS**
- **MR** $\leftrightarrow$ **OD**

---

**Speaking of positions of gaze…**

- **Nine**
  - One primary gaze (duh)…plus 'up' and 'down' make three. This implies (correctly) that there are **six cardinal positions of gaze**:
    - **Primary position (1)**
    - **Cardinal positions (6)**
    - **Up and down (2)**
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 Duane syndrome.

- **Hering's law**: Innervation 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.

Sherrington's Law vs Hering's Law

Speaking of positions of gaze…How many positions are used in evaluating ocular motility and alignment?

Nine

The nine positions are divided into three groups—what are they?

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

Likewise, the yoke muscles for gaze up and left are again the mirror image of those on the other side.
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 Duane syndrome.

- **Hering’s law**: Innervation 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.

**Sherrington’s Law vs Hering’s Law**

- **OD** → **SR**
- **OS** → **IO**
- **OD** → **LR**
- **OS** → **MR**

**Down and right**

**What are the yoke muscle for gaze down and right?**
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 Duane syndrome.

- **Hering’s law**: Innervation 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.

Sherrington’s Law vs Hering’s Law

Speaking of positions of gaze... How many positions are used in evaluating ocular motility and alignment?

Nine

The nine positions are divided into three groups—what are they?

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

What are the yoke muscles for gaze down and right?
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 Duane syndrome.

- **Hering’s law**: Innervation 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.

Speaking of positions of gaze…How many positions are used in evaluating ocular motility and alignment?

Nine

The nine positions are divided into three groups—what are they?

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

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

- **Hering’s law**: Innervation 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.

**Sherrington’s Law vs Hering’s Law**

Speaking of positions of gaze... How many positions are used in evaluating ocular motility and alignment? Nine

The nine positions are divided into three groups—what are they?

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

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? 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 there are six cardinal positions of gaze.

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

---

**Primary Position**:
- OD → IR (Down and right)
- OS → LR (Down and left)
- OD → OS (Left)
- OS → OD (Right)

**Cardinal Positions**: (Assuming the areas are labeled as shown in the diagram)
- OD → LR (Down and right)
- OS → MR (Down and left)
- OD → OS (Left)
- OS → OD (Right)

**Up and Down**: (Assuming the areas are labeled as shown in the diagram)
- OD → SR (Up and right)
- OS → IO (Up and left)
- OD → OS (Left)
- OS → OD (Right)

---

**Sherrington’s Law vs Hering’s Law**

The cardinal positions of gaze, and the yoke muscles for each (summary slide—proceed when ready)
Define **Sherrington’s law** and **Hering’s law**

- **Sherrington’s law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist. Violated in Duane syndrome.

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

Speaking of Hering’s law…What determines the total amount of innervational input the eyes receive?
Define Sherrington’s law and Hering’s law:

- **Sherrington’s law**: Increased innervation to a muscle is accompanied by decreased innervation to its antagonist. Violated in Duane syndrome.

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

Speaking of Hering’s law…What determines the total amount of innervational input the eyes receive? It is determined by the amount of innervation needed for the fixating eye to get into and maintain position.
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.

Speaking of Hering’s law…What determines the total amount of 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?
Define Sherrington’s law and Hering’s law.

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

Speaking of Hering’s law... What determines the total amount of 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.
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...Duane syndrome

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

Speaking of Hering’s law...What determines the total amount of 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.**
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. 

Sherrington's law vs Hering's law

Speaking of Hering's law...What determines the total amount of 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.

Hering's law

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

Violated in Duane syndrome.
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 Duane syndrome.

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

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.

**Sherrington's Law vs Hering's Law**

Speaking of Hering's law... What determines the total amount of 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.
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 Duane syndrome

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

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 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.

Speaking of Hering's law...What determines the total amount of 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.
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 Duane syndrome

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

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 cause the eye to ADduct, 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.

Speaking of Hering’s law...What determines the total amount of 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.**
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. 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 **primary deviation**. Whereas 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**

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.**
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…Duane syndrome

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

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. whereas the amount of 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.
Pt with left LR palsy

OD fixating (= primary deviation)
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 Duane syndrome.

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

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

Hering’s law

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.
Pt with left LR palsy

OS fixating (= secondary deviation)
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.

Hering's law is the reason these measurements are not identical, and why the secondary deviation is always larger.

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 states that the total innervational input the eyes receive 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.
Pt with left LR palsy (side-by-side for comparison purposes)

OD fixating (= primary deviation)  OS fixating (= secondary deviation)
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...

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

OK, now back to a question about Sherrington’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... **Duane syndrome**

- **Hering’s law**: Innervation to yoke muscles is equal
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: Duane syndrome

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

Briefly, what is Duane syndrome?

Duane syndrome is a motility disorder with the following key findings:

- At least some limitation of horizontal movement
- Attempted adduction causes the globe to retract, and may cause it to up- or downshoot

What is the cause?

The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III.
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: **Duane syndrome**

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

**Briefly, what is Duane syndrome?**

A motility disorder with the following key findings:

- At least some limitation of horizontal movement
- Attempted movement causes the globe to move in the opposite direction, and may cause it to up- or downshoot

What is the cause?

The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III.

**Duane syndrome**
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: Duane syndrome*

**Hering’s law**: Innervation to yoke muscles is equal.

*Briefly, what is Duane syndrome?* A motility disorder with the following key findings:

-- At least some limitation of horizontal movement
-- Attempted adduction causes the globe to retract, and may cause it to up- or downshoot

**Duane syndrome**
Horizontal movement limitation

Duane syndrome
Horizontal movement limitation

Globe retraction

Duane syndrome
Horizontal movement limitation

Globe retraction

Duane syndrome
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 **Duane syndrome**

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

**Briefly, what is Duane syndrome?**
A motility disorder with the following key findings:
- At least some limitation of horizontal movement
- Attempted adduction causes the globe to retract, and may cause it to up- or downshoot

**What is the cause?**

The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III.
```markdown
Q/A

**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: **Duane syndrome**
  - **Hering’s law:** Innervation to yoke muscles is equal.

---

**Briefly, what is Duane syndrome?**
A motility disorder with the following key findings:
-- At least some limitation of horizontal movement
-- Attempted adduction causes the globe to retract, and may cause it to up- or downshoot

**What is the cause?**
The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III.
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: Duane syndrome

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

*Briefly, what is Duane syndrome?*
A motility disorder with the following key findings:
- At least some limitation of horizontal movement
- Attempted adduction causes the globe to retract, and may cause it to up- or downshoot

*What is the cause?*
The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III.
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: **Duane syndrome**

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

---

**Briefly, what is Duane syndrome?**
A motility disorder with the following key findings:

- At least some limitation of horizontal movement
- Attempted adduction causes the globe to retract, and may cause it to up- or downshoot

**What is the cause?**
The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III.

---

**How does this dysinnervation result in the key findings listed above?**
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 Duane syndrome.

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

**Briefly, what is Duane syndrome?**
A motility disorder with the following key findings:
- At least some limitation of horizontal movement
- Attempted adduction causes the globe to retract, and may cause it to up- or downshoot

**What is the cause?**
The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III.

How does this dysinnervation result in the key findings listed above?
When someone with an intact oculomotor system adducts an eye, Sherrington’s law dictates that innervation is increased to the medial rectus and decreased to the lateral rectus.
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: Duane syndrome

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

**Briefly, what is Duane syndrome?**
A motility disorder with the following key findings:
- At least some limitation of horizontal movement
- Attempted adduction causes the globe to retract, and may cause it to up- or downshoot

**What is the cause?**
The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III.

**How does this dysinnervation result in the key findings listed above?**
When someone with an intact oculomotor system adducts an eye, Sherrington’s law dictates that innervation is increased to the medial rectus and decreased to the lateral rectus. However, in a Duane’s pt CN3 innervates the LR, so when she attempts to adduct her eye, innervation is increased to both the medial rectus and the aberrantly-innervated lateral rectus, so the eye doesn’t adduct.
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... Duane syndrome

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

**Briefly, what is Duane syndrome?**
A motility disorder with the following key findings:
- At least some **limitation of horizontal movement**
- Attempted adduction causes the globe to retract, and may cause it to up- or downshoot

**What is the cause?**
The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III

**How does this dysinnervation result in the key findings listed above?**
When someone with an intact oculomotor system adducts an eye, Sherrington’s law dictates that innervation is increased to the medial rectus and decreased to the lateral rectus. However, in a Duane’s pt CN3 innervates the LR, so when she attempts to adduct her eye, innervation is increased to both the medial rectus and the aberrantly-innervated lateral rectus, so the eye doesn’t adduct. And when two muscles on opposite sides of the eye contract simultaneously, the net result will be that the eye will retract.
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: **Duane syndrome**

  *Briefly, what is Duane syndrome?*
  A motility disorder with the following key findings:
  - At least some **limitation of horizontal movement**
  - Attempted adduction causes the globe to **retract**, and may cause it to **up- or downshoot**

  *What is the cause?*
  The nucleus for cranial nerve VI is missing, and the lateral rectus is innervated by cranial nerve III

*How does this dysinnervation result in the key findings listed above?*
When someone with an intact oculomotor system adducts an eye, Sherrington’s law dictates that innervation is increased to the medial rectus and decreased to the lateral rectus. However, in a Duane’s pt CN3 innervates the LR, so when she attempts to adduct her eye, innervation is increased to both the medial rectus and the aberrantly-innervated lateral rectus, **so the eye doesn’t adduct**. And when two muscles on opposite sides of the eye contract simultaneously, the net result will be that the eye will **retract**. Further, if this co-contraction is sufficiently vigorous, one or the other rectus muscle might ‘slip’ upwards or downwards, causing the eye to **up- or downshoot**.
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... **Duane syndrome**
- **Hering’s law**: Innervation to **yoke muscles** is equal
  - Violated in... **strabismic condition (3 words)**
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... **Duane syndrome**

- **Hering’s law**: Innervation to *yoke muscles* is equal
  - Violated in... **dissociated vertical deviation (DVD)**
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... *Duane syndrome*

**Hering’s law**: Innervation to yoke muscles is equal

Violated in... *dissociated vertical deviation (DVD)*

---

**Who is the typical DVD pt?**

A child with infantile/congenital ET or XT

**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).

**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**.
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 Duane syndrome.

- **Hering’s law**: Innervation to yoke muscles is equal. Violated in dissociated vertical deviation (DVD).

**Who is the typical DVD pt?**
A child with infantile/congenital ET or XT.

**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).

**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.
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 Duane syndrome.

- **Hering’s law**: Innervation to yoke muscles is equal.
  - Violated in dissociated vertical deviation (DVD).

Who is the typical DVD pt?
A child with infantile/congenital ET or XT

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).

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.
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 **Duane syndrome**.

- **Hering’s law**: Innervation to yoke muscles is equal.
  - Violated in **dissociated vertical deviation (DVD)**.

**Who is the typical DVD pt?**
A child with infantile/congenital ET or XT

**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).
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 **Duane syndrome**.

- **Hering's law**: Innervation to yoke muscles is equal.
  - Violated in **dissociated vertical deviation (DVD)**.

**Who is the typical DVD pt?**
A child with infantile/congenital ET or XT.

**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).

**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.
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 Duane syndrome.

- **Hering’s law**: Innervation to yoke muscles is equal.
  - Violated in dissociated vertical deviation (DVD).

**Who is the typical DVD pt?**
A child with infantile/congenital ET or XT

**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).

**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.
Sherrington’s Law vs Hering’s Law

Speaking of EOM innervation...

What is the ratio of nerve fibers to muscle fibers in the EOMs?
Speaking of EOM innervation…

What is the ratio of nerve fibers to muscle fibers in the EOMs? 1:3–1:5, ie, 1 nerve fiber for every 3-5 muscle fibers
Sherrington’s Law vs Hering’s Law

**Speaking of EOM innervation…**

*What is the ratio of nerve fibers to muscle fibers in the EOMs?*

1:3–1:5, ie, 1 nerve fiber for every 3-5 muscle fibers

*When compared with that of skeletal muscle, is this ratio high, or low?*
Sherrington’s Law vs Hering’s Law

Speaking of EOM innervation…

What is the ratio of nerve fibers to muscle fibers in the EOMs?
1:3–1:5, ie, 1 nerve fiber for every 3-5 muscle fibers

When compared with that of skeletal muscle, is this ratio high, or low?
Very high (in skeletal muscle, typical ratios are in the 1:x to 1:x range)
What is the ratio of nerve fibers to muscle fibers in the EOMs?
1:3–1:5, ie, 1 nerve fiber for every 3-5 muscle fibers

When compared with that of skeletal muscle, is this ratio high, or low?
Very high (in skeletal muscle, typical ratios are in the 1:50 to 1:125 range)
Speaking of EOM innervation…

What is the ratio of nerve fibers to muscle fibers in the EOMs? 1:3–1:5, ie, 1 nerve fiber for every 3-5 muscle fibers

When compared with that of skeletal muscle, is this ratio high, or low? Very high (in skeletal muscle, typical ratios are in the 1:50 to 1:125 range)

What impact does the high nerve fiber/muscle fiber ratio have on EOM control?
What is the ratio of nerve fibers to muscle fibers in the EOMs?
1:3–1:5, ie, 1 nerve fiber for every 3-5 muscle fibers

When compared with that of skeletal muscle, is this ratio high, or low?
Very high (in skeletal muscle, typical ratios are in the 1:50 to 1:125 range)

What impact does the high nerve fiber/muscle fiber ratio have on EOM control?
It allows for great precision and accuracy in the control of ocular movements
**Speaking of EOM innervation…**

What is the ratio of nerve fibers to muscle fibers in the EOMs?
1:3–1:5, ie, 1 nerve fiber for every 3-5 muscle fibers

When compared with that of skeletal muscle, is this ratio high, or low?
Very high (in skeletal muscle, typical ratios are in the 1:50 to 1:125 range)

What impact does the high nerve fiber/muscle fiber ratio have on EOM control?
It allows for great precision and accuracy in the control of ocular movements

The EOMs are composed of two types of muscle fibers—what are they?

<table>
<thead>
<tr>
<th>Types</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>?</td>
<td></td>
<td></td>
</tr>
<tr>
<td>?</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Speaking of EOM innervation…

What is the ratio of nerve fibers to muscle fibers in the EOMs?
1:3–1:5, ie, 1 nerve fiber for every 3-5 muscle fibers

When compared with that of skeletal muscle, is this ratio high, or low?
Very high (in skeletal muscle, typical ratios are in the 1:50 to 1:125 range)

What impact does the high nerve fiber/muscle fiber ratio have on EOM control?
It allows for great precision and accuracy in the control of ocular movements

The EOMs are composed of two types of muscle fibers—what are they?

<table>
<thead>
<tr>
<th>Types</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow/tonic</td>
<td></td>
</tr>
<tr>
<td>Fast/twitchy</td>
<td></td>
</tr>
</tbody>
</table>
Speaking of EOM innervation…

What is the ratio of nerve fibers to muscle fibers in the EOMs?  
1:3–1:5, ie, 1 nerve fiber for every 3-5 muscle fibers

When compared with that of skeletal muscle, is this ratio high, or low?  
Very high (in skeletal muscle, typical ratios are in the 1:50 to 1:125 range)

What impact does the high nerve fiber/muscle fiber ratio have on EOM control?  
It allows for great precision and accuracy in the control of ocular movements

The EOMs are composed of two types of muscle fibers—what are they? In what manner is each type innervated?

(Hint forthcoming)

<table>
<thead>
<tr>
<th>Types</th>
<th>Innervation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow/tonic</td>
<td>?</td>
</tr>
<tr>
<td>Fast/twitchy</td>
<td>?</td>
</tr>
</tbody>
</table>
Speaking of EOM innervation…

What is the ratio of nerve fibers to muscle fibers in the EOMs?
1:3–1:5, ie, 1 nerve fiber for every 3-5 muscle fibers

When compared with that of skeletal muscle, is this ratio high, or low?
Very high (in skeletal muscle, typical ratios are in the 1:50 to 1:125 range)

What impact does the high nerve fiber/muscle fiber ratio have on EOM control?
It allows for great precision and accuracy in the control of ocular movements

The EOMs are composed of two types of muscle fibers—what are they? In what manner is each type innervated?

(Thar she blows!)

<table>
<thead>
<tr>
<th>Types</th>
<th>Innervation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow/tonic</td>
<td>En</td>
</tr>
<tr>
<td>Fast/twitchy</td>
<td>En</td>
</tr>
</tbody>
</table>
Speaking of EOM innervation…

What is the ratio of nerve fibers to muscle fibers in the EOMs?
1:3–1:5, ie, 1 nerve fiber for every 3-5 muscle fibers

When compared with that of skeletal muscle, is this ratio high, or low?
Very high (in skeletal muscle, typical ratios are in the 1:50 to 1:125 range)

What impact does the high nerve fiber/muscle fiber ratio have on EOM control?
It allows for great precision and accuracy in the control of ocular movements

The EOMs are composed of two types of muscle fibers—what are they? In what manner is each type innervated?

<table>
<thead>
<tr>
<th>Types</th>
<th>Innervation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow/tonic</td>
<td><em>En grappe</em></td>
</tr>
<tr>
<td>Fast/twitchy</td>
<td><em>En plaque</em></td>
</tr>
</tbody>
</table>
What is the ratio of nerve fibers to muscle fibers in the EOMs?
1:3–1:5, ie, 1 nerve fiber for every 3-5 muscle fibers

When compared with that of skeletal muscle, is this ratio high, or low?
Very high (in skeletal muscle, typical ratios are in the 1:50 to 1:125 range)

What impact does the high nerve fiber/muscle fiber ratio have on EOM control?
It allows for great precision and accuracy in the control of ocular movements

The EOMs are composed of two types of muscle fibers—what are they? In what manner is each type innervated?

<table>
<thead>
<tr>
<th>Types</th>
<th>Innervation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow/tonic</td>
<td><em>En grappe</em></td>
</tr>
<tr>
<td>Fast/twitchy</td>
<td><em>En plaque</em></td>
</tr>
</tbody>
</table>

*What does en grappe mean?*
**Speaking of EOM innervation…**

What is the ratio of nerve fibers to muscle fibers in the EOMs? 1:3–1:5, ie, 1 nerve fiber for every 3-5 muscle fibers

When compared with that of skeletal muscle, is this ratio high, or low? Very high (in skeletal muscle, typical ratios are in the 1:50 to 1:125 range)

What impact does the high nerve fiber/muscle fiber ratio have on EOM control? It allows for great precision and accuracy in the control of eye movements

The EOMs are composed of two types of muscle fibers. What are they? In what manner is each type innervated?

<table>
<thead>
<tr>
<th>Types</th>
<th>Innervation</th>
<th>What does en grappe mean? It means ‘grape-like’</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow/tonic</td>
<td><strong>En grappe</strong></td>
<td></td>
</tr>
<tr>
<td>Fast/twitchy</td>
<td><strong>En plaque</strong></td>
<td></td>
</tr>
</tbody>
</table>
Sherrington’s Law vs Hering’s Law

EOM innervation: *En grappe* vs *en plaque*
Speaking of EOM innervation…

What is the ratio of nerve fibers to muscle fibers in the EOMs?  
1:3–1:5, ie, 1 nerve fiber for every 3-5 muscle fibers

When compared with that of skeletal muscle, is this ratio high, or low?  
Very high (in skeletal muscle, typical ratios are in the 1:50 to 1:125 range)

What impact does the high nerve fiber/muscle fiber ratio have on EOM control?  
it allows for great precision and accuracy in the control of ocular movements

The EOMs are composed of two types of muscle fibers—what are they? In what manner is each type innervated? What sort of movement is each responsible for?

<table>
<thead>
<tr>
<th>Types</th>
<th>Innervation</th>
<th>Movement type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Slow/tonic</td>
<td>En grappe</td>
<td>?</td>
</tr>
<tr>
<td>Fast/twitchy</td>
<td>En plaque</td>
<td>?</td>
</tr>
</tbody>
</table>
What is the ratio of nerve fibers to muscle fibers in the EOMs?
1:3–1:5, i.e., 1 nerve fiber for every 3-5 muscle fibers

When compared with that of skeletal muscle, is this ratio high, or low?
Very high (in skeletal muscle, typical ratios are in the 1:50 to 1:125 range)

What impact does the high nerve fiber/muscle fiber ratio have on EOM control?
It allows for great precision and accuracy in the control of ocular movements

The EOMs are composed of two types of muscle fibers—what are they? In what manner is each type innervated? What sort of movement is each responsible for?