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HUMAN MOVEMENT MOTOR CONTROL

APA 1161

Dr. Carla Geurts

Today's Class Objectives

1. Understand the area of motor control
2. Think about why you need to understand motor control
3. Describe the key players in motor control (CNS)
4. Understand difference between reflex movements and voluntary movements

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The Field of Psychomotor Behaviour

Psychomotor = All motor functions and their relationship to mental activities (thinking, brain function, etc.)

Three interconnected areas

1. Motor Control
2. Motor Development
3. Motor Learning

Today's class: Motor Control

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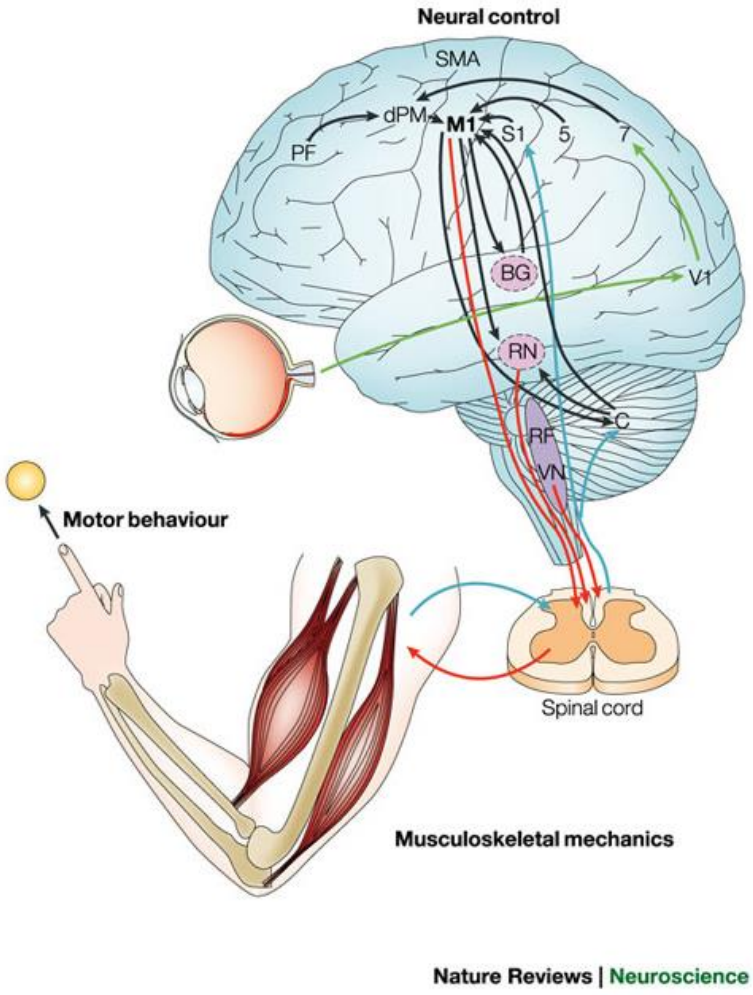
Defining Motor Control

Motor Control refers to nervous system's control of muscles to permit skilled and coordinated momvement



Why studying motor control?

Used in rehab/theories

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Researchers in SHK

- Dr. Cressman's research examines how the brain processes sensory information for goal-directed action

- Dr. Carlsen's research focusses on the early preparation and initiation of the voluntary movements and their associated synergies in both healthy population and populations with disordered movements

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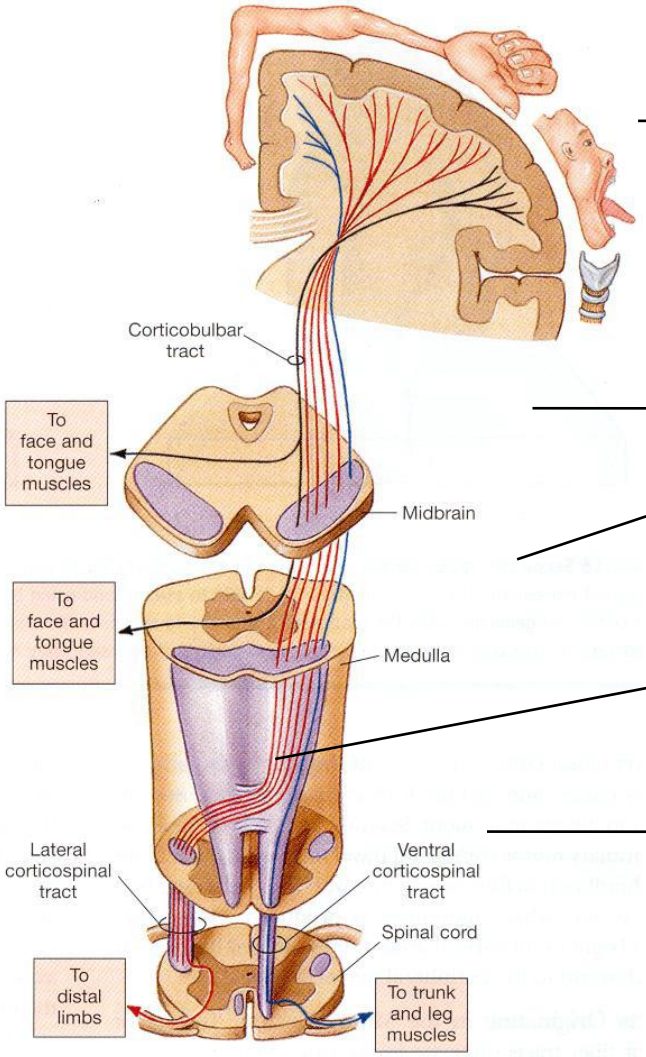
Basic Overview of Central Nervous System (CNS)



Cortex

Midbrain and Brainstem

Hemispheres project contralaterally

Spinal Cord

Central Nervous System

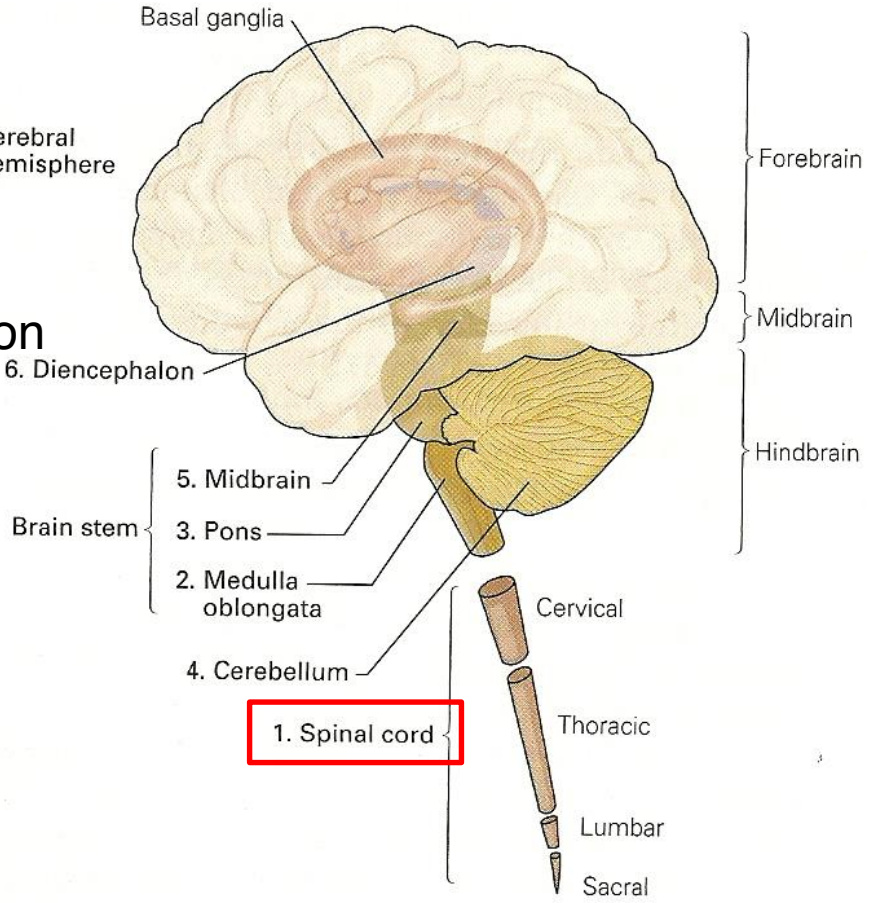
1. **Spinal cord**:

Executing level: sends signal to the brain and it sends movement to the brain

a.) Receives and processes sensory information

b.) Controls movement (CPG) - sequencing of motor plan almost like a reflex that is put in place and go automatically

INJURY: Will not get any information from the brain, but could still have movements: reflex



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Nerve Cells and Spinal Cord

Amyotrophic Lateral Sclerosis (ALS)
Lou Gehrig

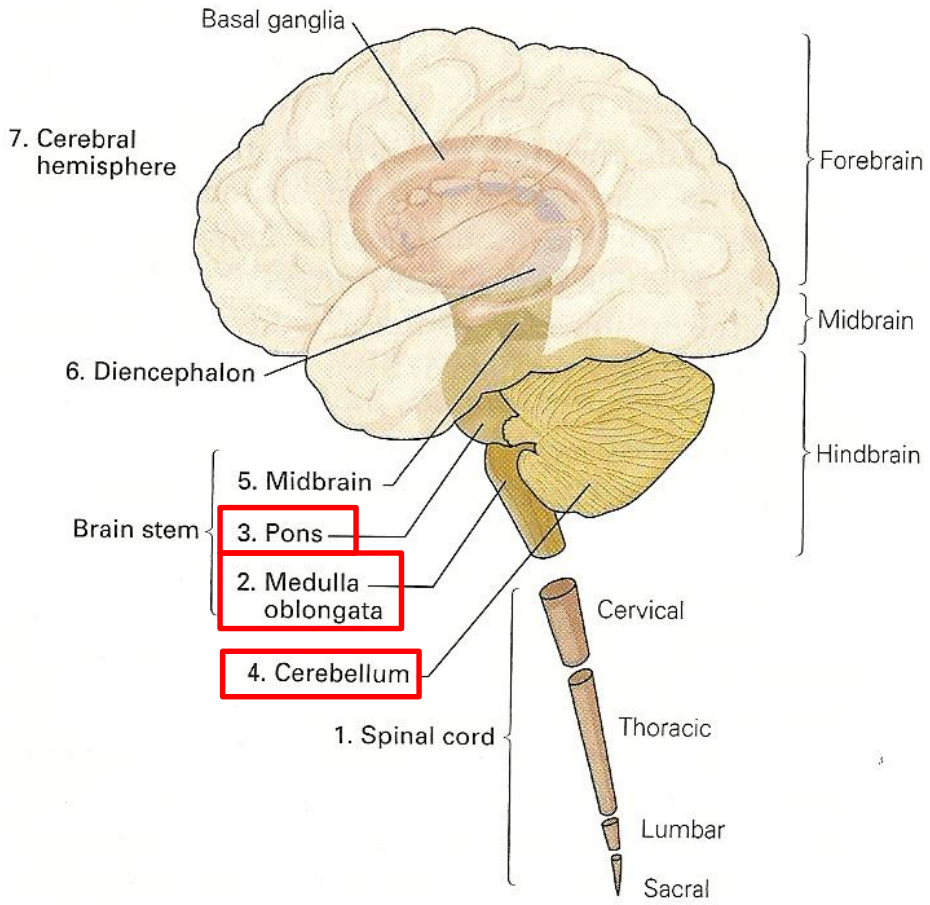
Spinal Cord Injury (SCI)
Chris Reeves

Central Nervous System

2. **Medulla Oblongata**:
autonomous life support: digestion

3. **Pons**:
transmits information from hemisphere to cerebellum and regulates the level of arousal

4. **Cerebellum**:
modulates the strength and range of motion that is involved in motor learning



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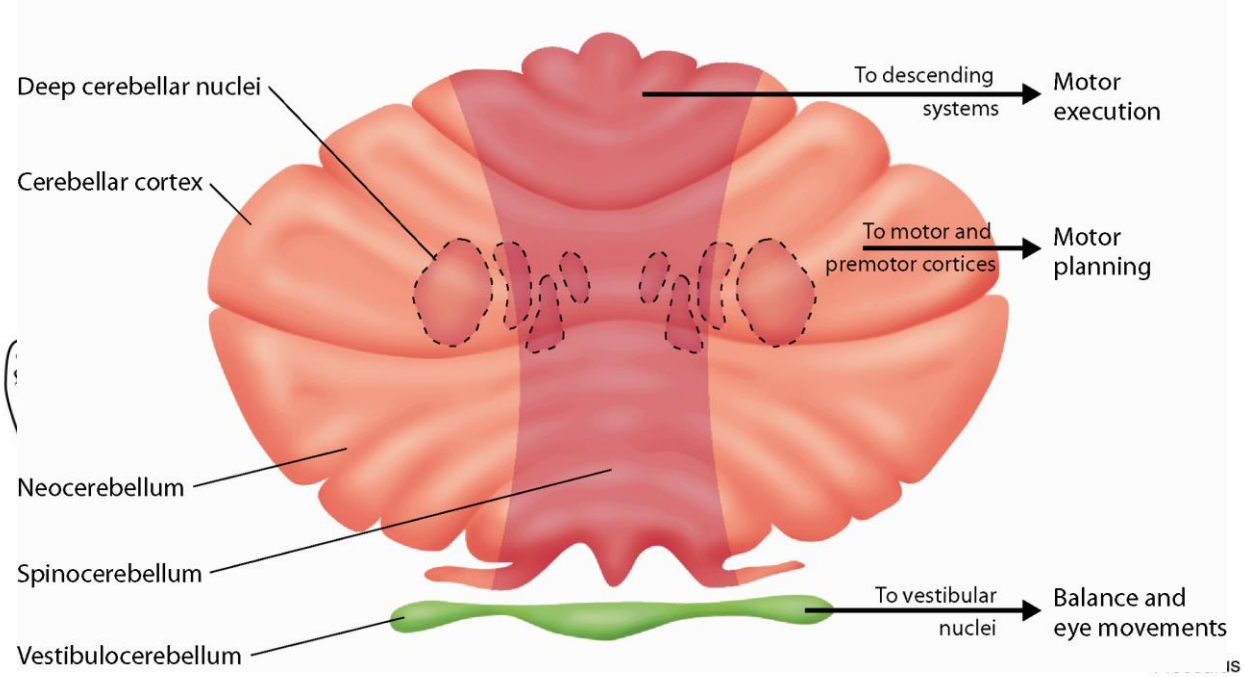
The Cerebellum



Vestibulocerebellum:
- Balance and Stability
- Vestibular System

Spinocerebellum:
- Receives sensory information from the spinal cord
- Important for the control of movement (*smooth*)
- Especially the coordination of the trunk

Neocerebellum:
- Does not receive information from the spinal cord but receives projections from the cortex
- Internal model/representation of our world
- Laceration causes ataxia (clumsiness)

Cerebellar Ataxia

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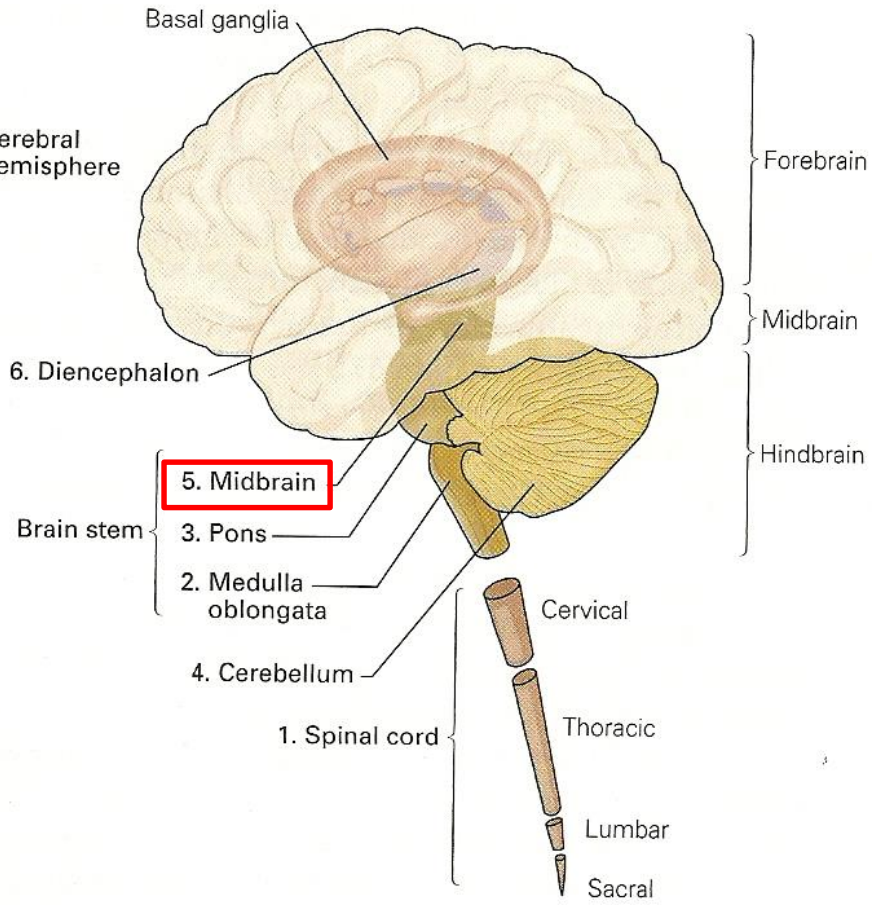
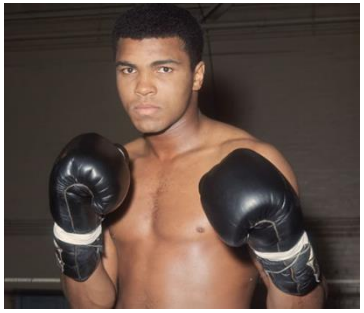
Central Nervous System

5. **The Midbrain**:

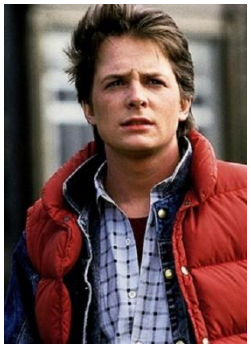
Connection of motor context and the rest of the body. Controls sensory functions; eye functions and visual and auditory reflexes. Has the info from visual stimuli

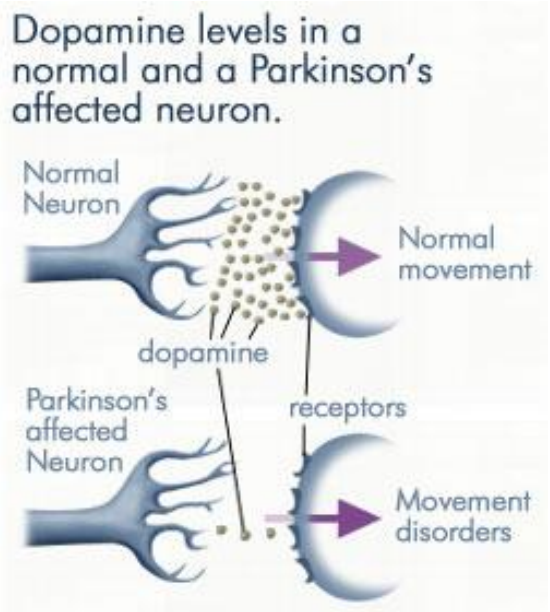


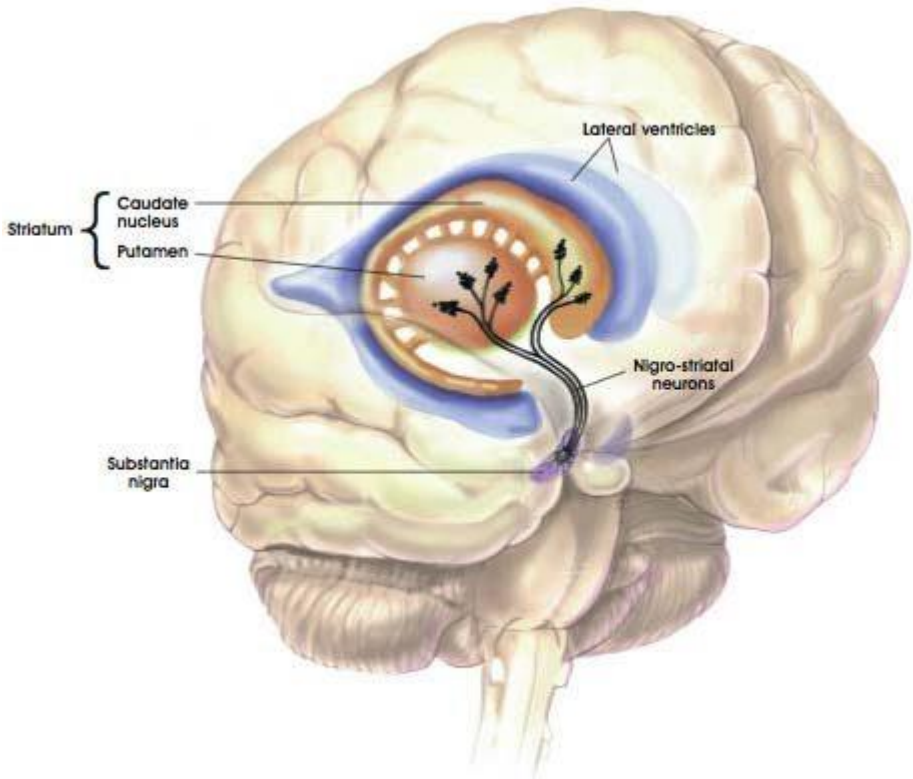
Parkinson Disease



- Michael J Fox, Mohammed Ali







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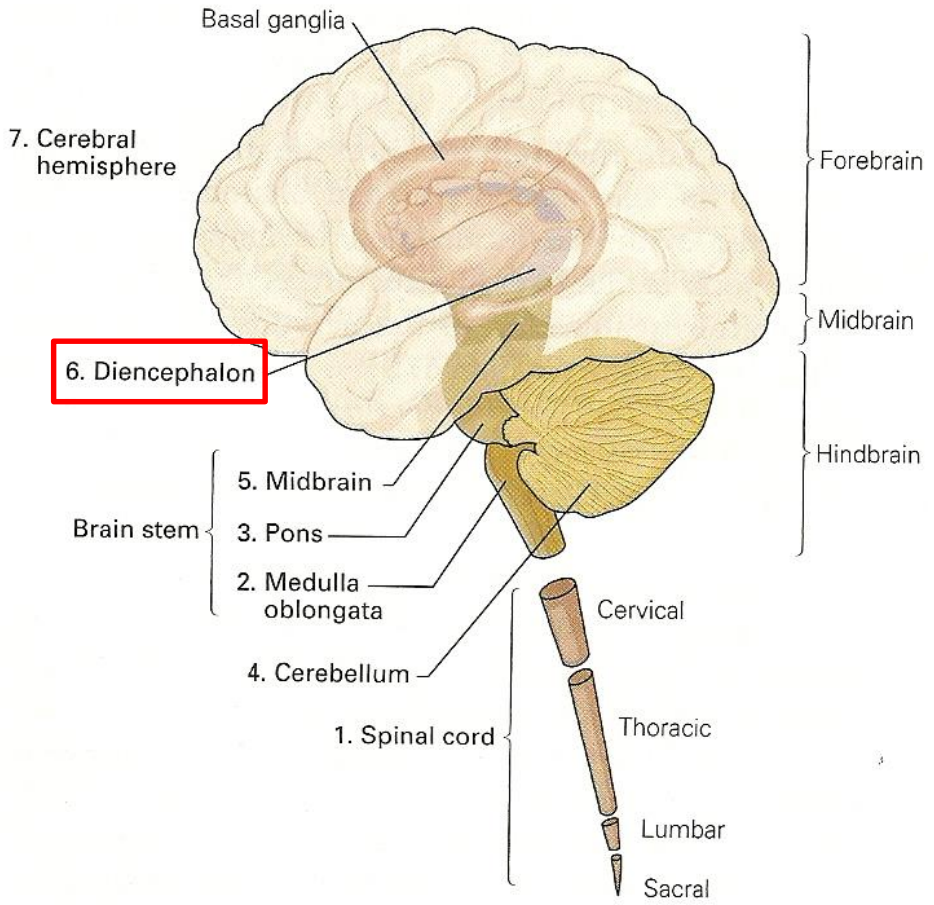
VIDEO

Central Nervous System

6. **The diencephalon:**

Thalamus: involved in the brain

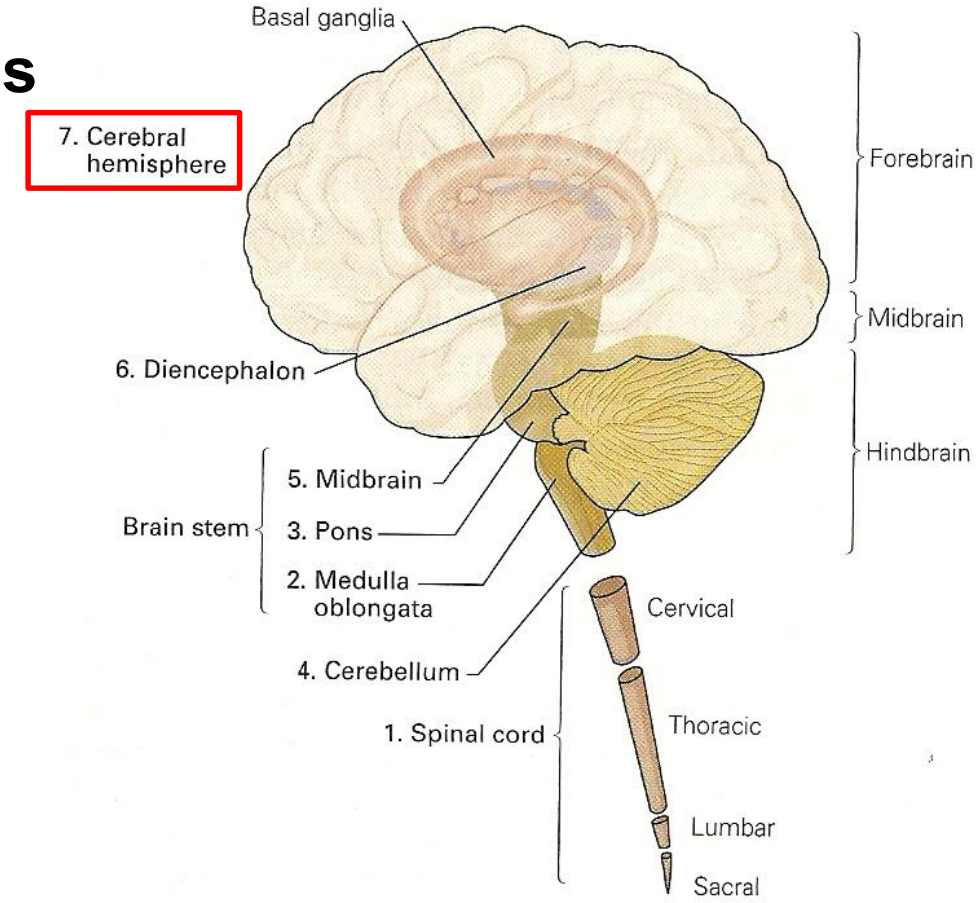
Hypothalamus: involved in homeostasis (regulates body temperature), hunger, thirst



Central Nervous System

7. **The cerebral hemispheres**
   - The cerebral cortex

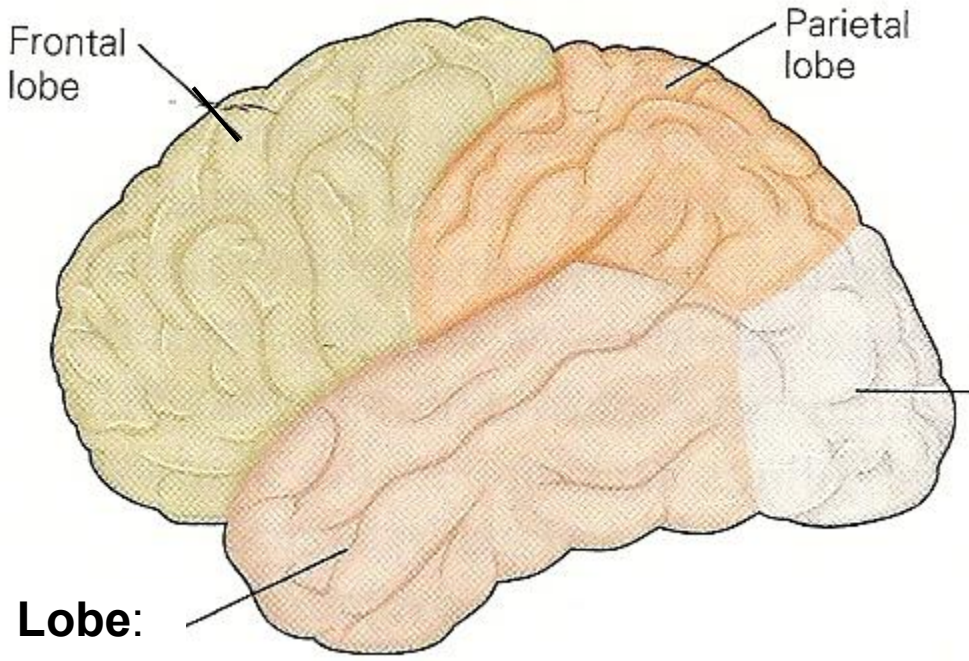
is divided into four hemispheres
- Frontal: Motor cortex
- Parietal: Sensory integration
- Occipital: Visual cortex
- Temporal: Hearing, speech, and memory



Cerebral Cortex

Frontal Lobe : Motor cortex

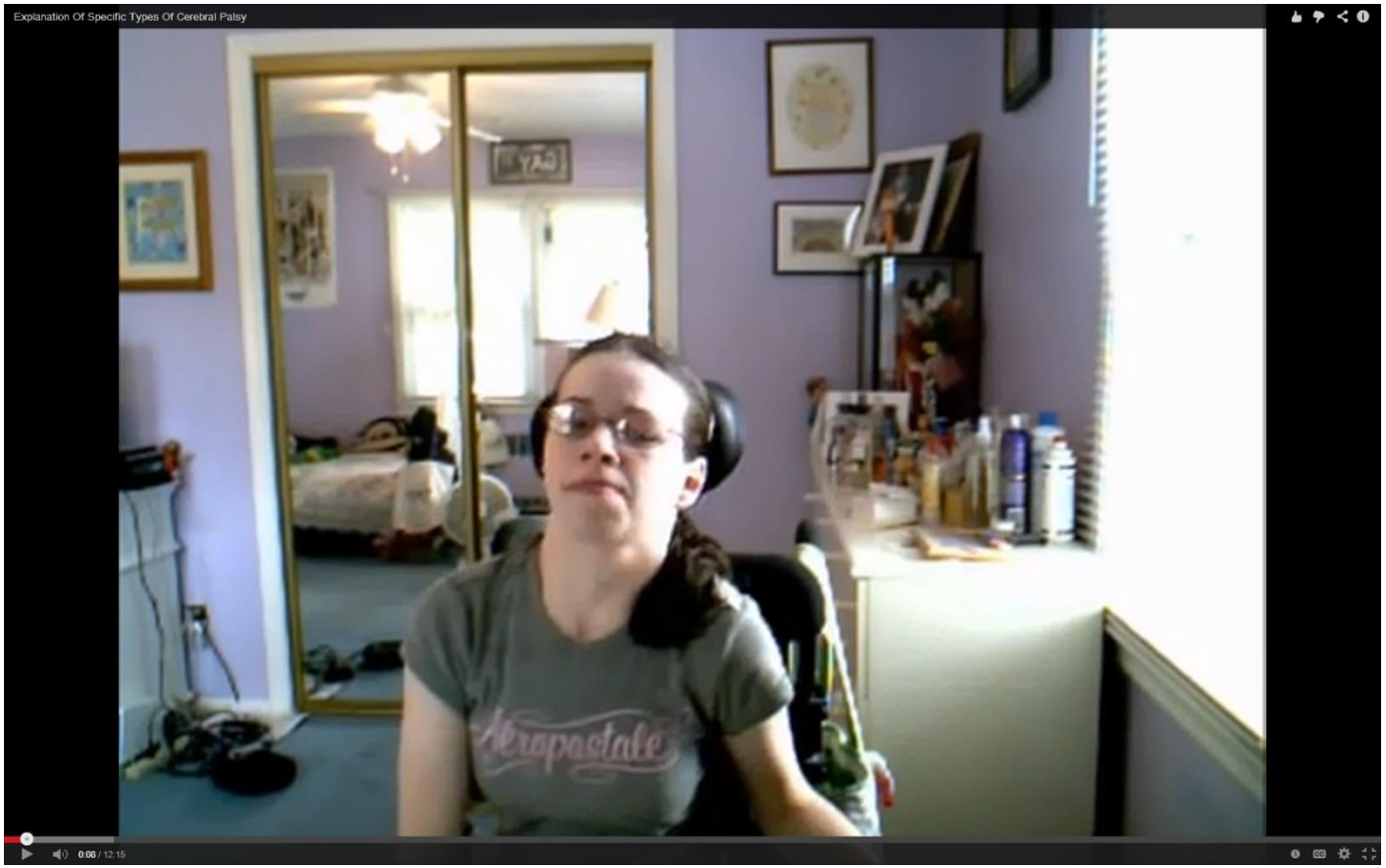
Parietal Lobe :
Sensory integration



Occipital Lobe:
Visual cortex

Temporal Lobe:
Hearing, speech, and memory

Cerebral Palsy



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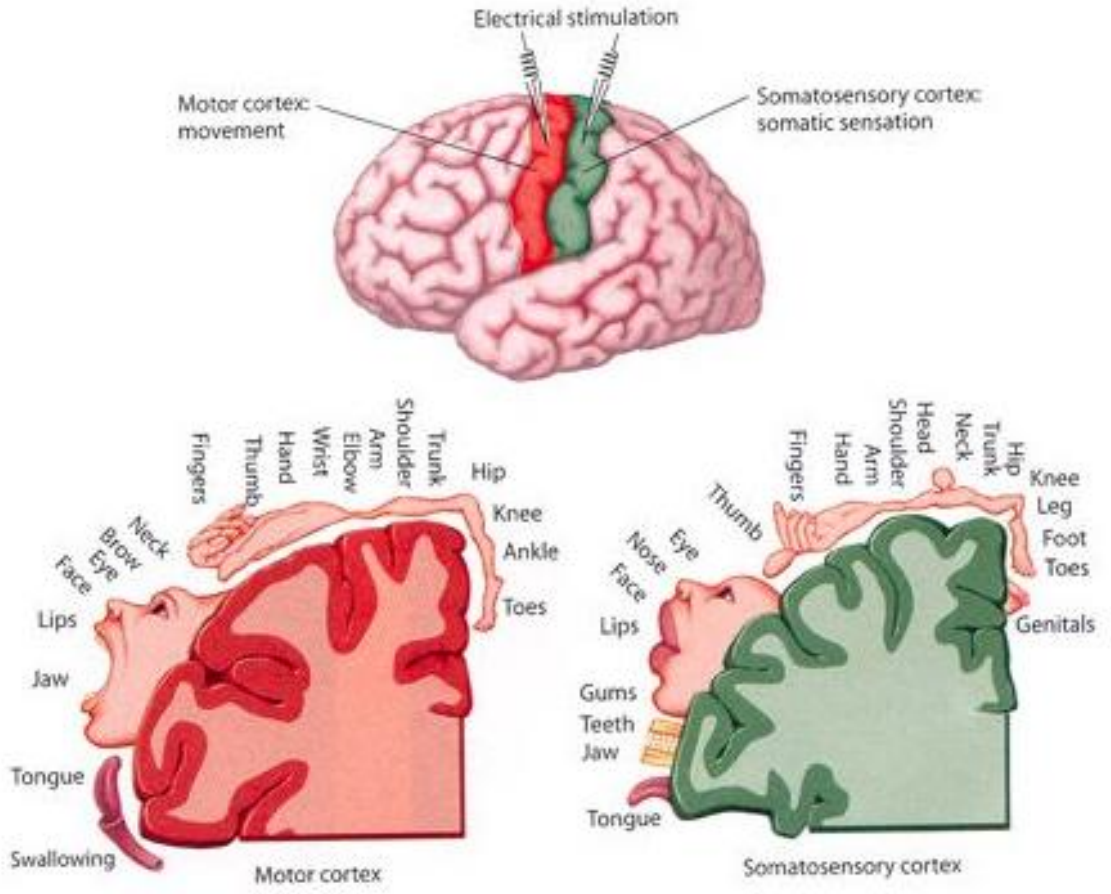
Updated: https://www.youtube.com/watch?v=h8yZHdEaYyM

Brain Mapping by Electrical Stimulation



Homunculus (3D)

REFLEX VS. VOLUNTARY MOVEMENTS

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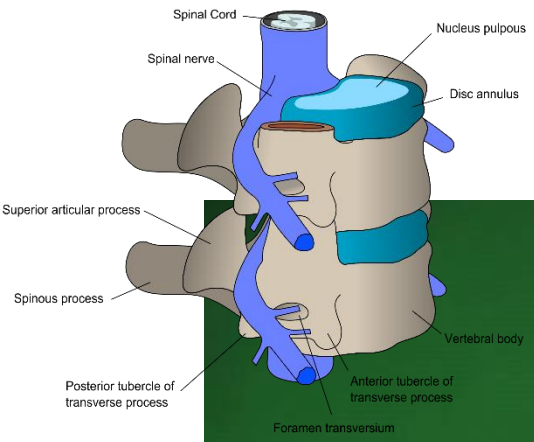
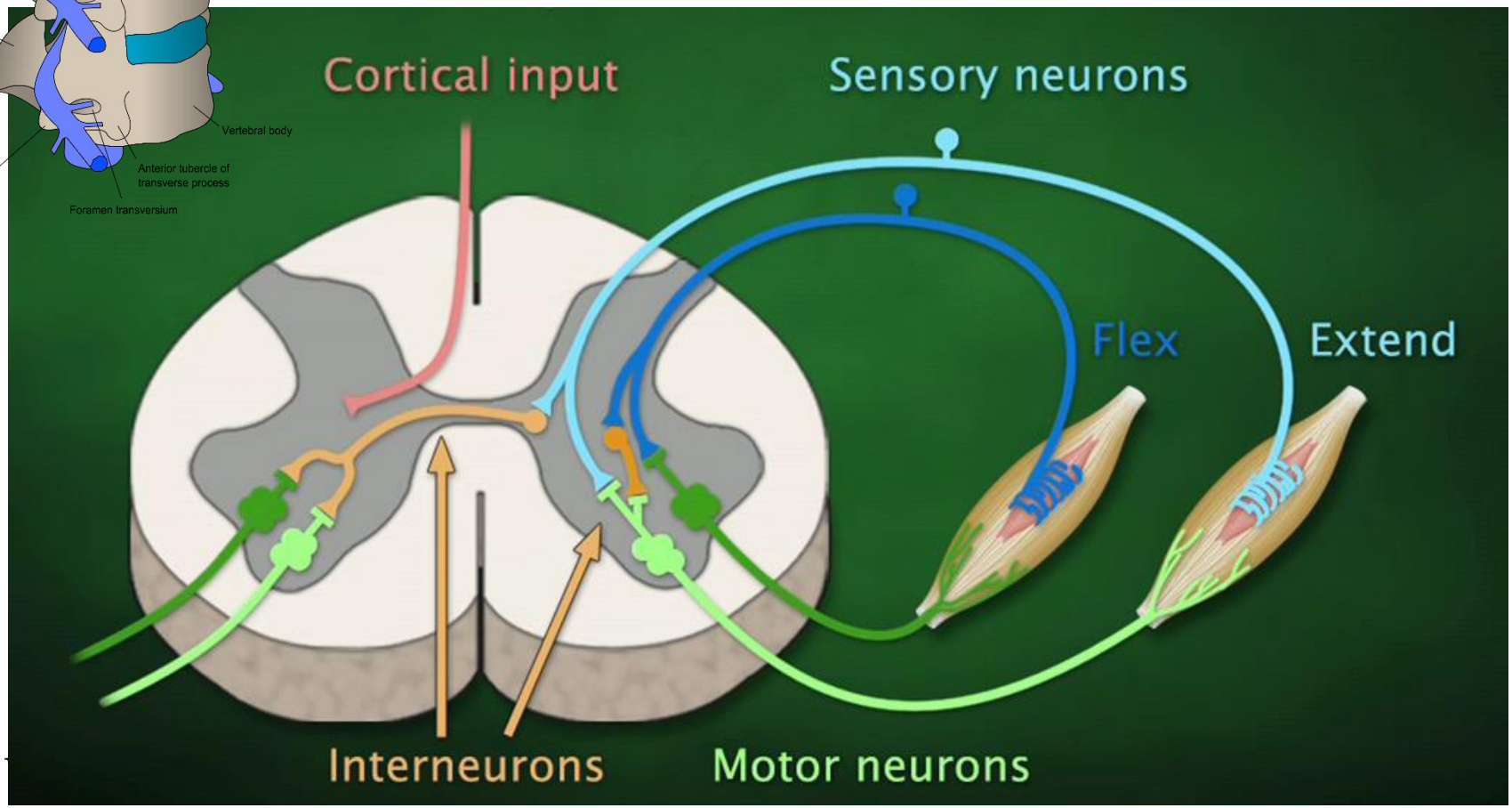
Motor Control – Spinal Motor Circuit

Sensory (quick loop): from muscle to brain

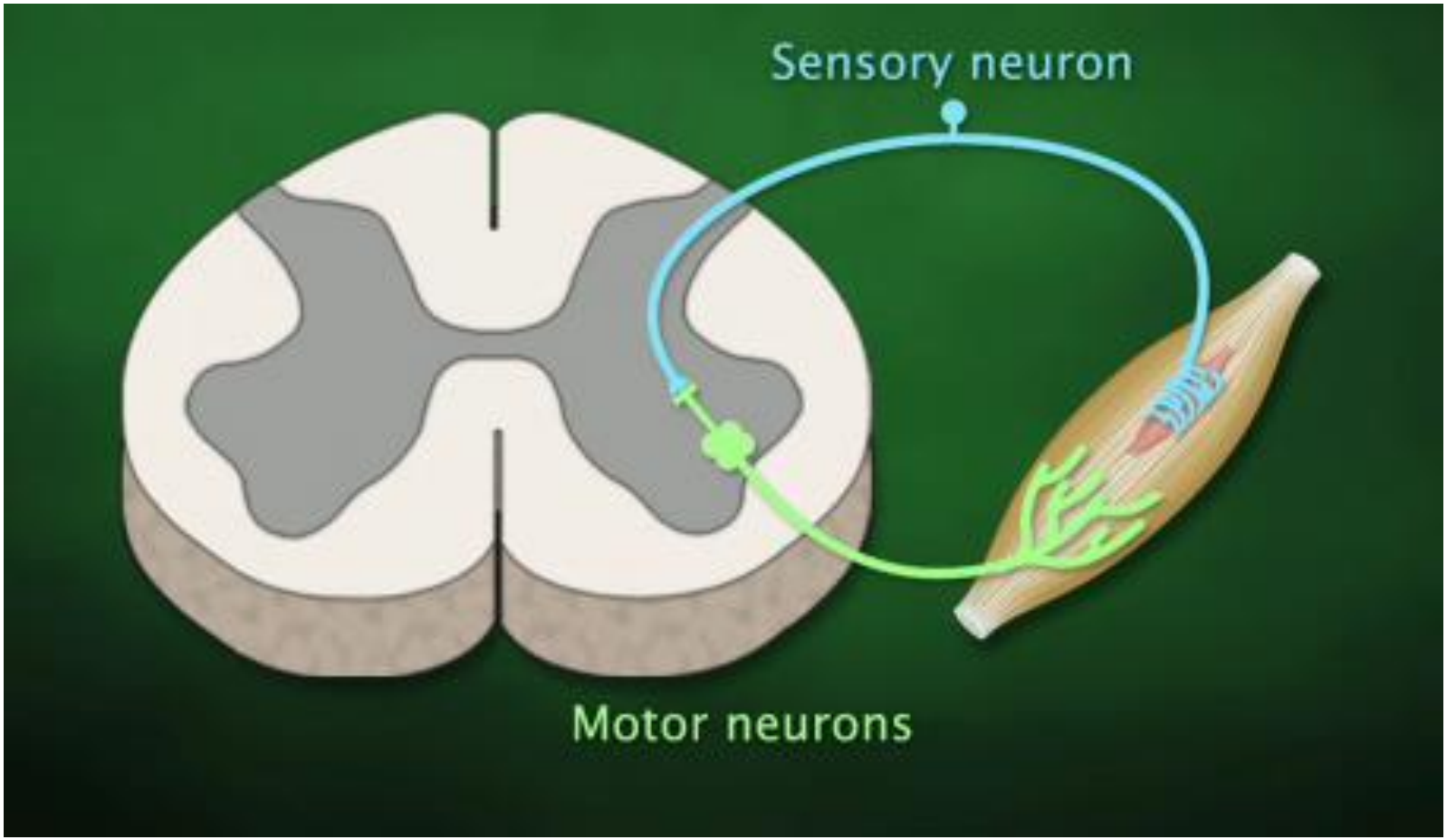
Motor: from brain to muscle





Proprioceptive Sensory Feedback

fastest reflex



Reflex Theory

by Sir Charles Sherrington

Reflex arc:

Receptor, conductor, and effector

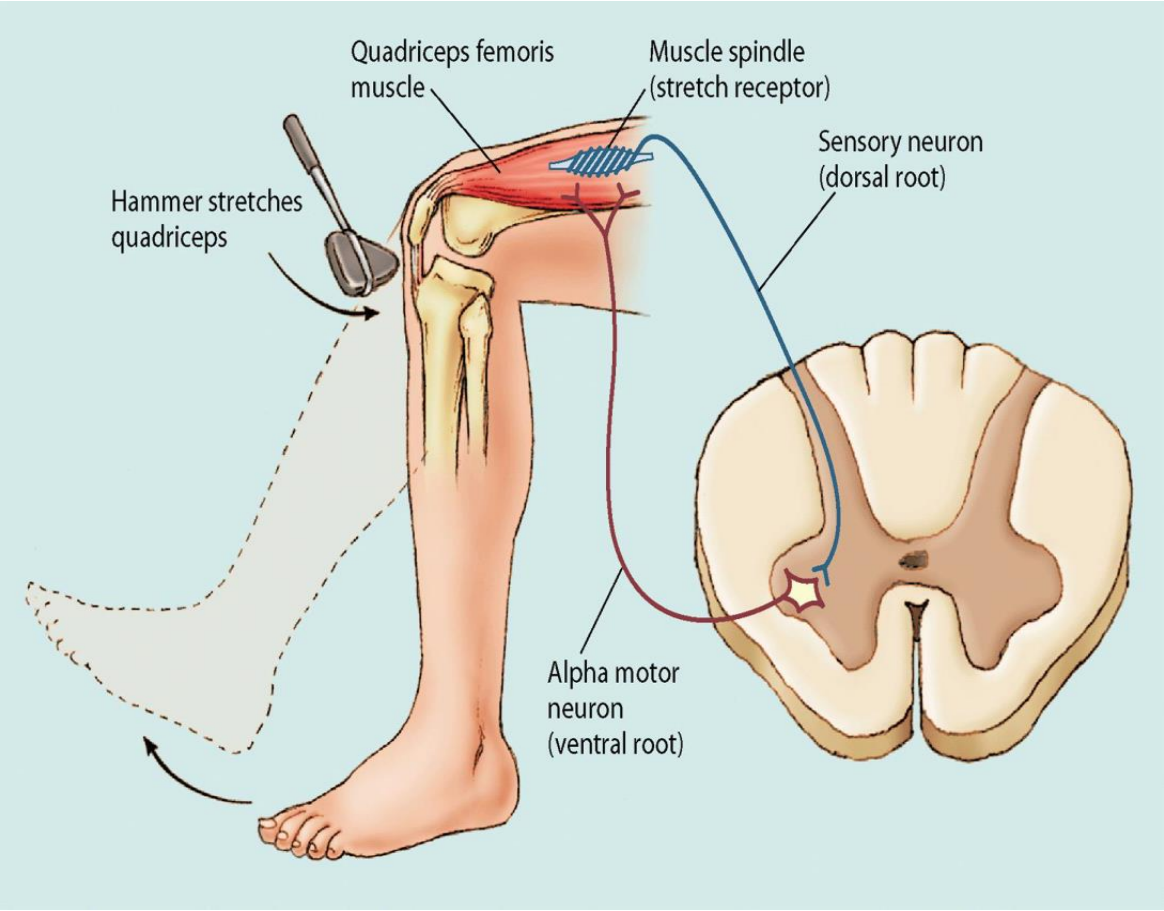
Behaviour:

Stimulus → Response (monosynaptic)

or

Stimulus → Response → Response (polysynaptic)

Simple (Monosynapic) Reflex:30 ms



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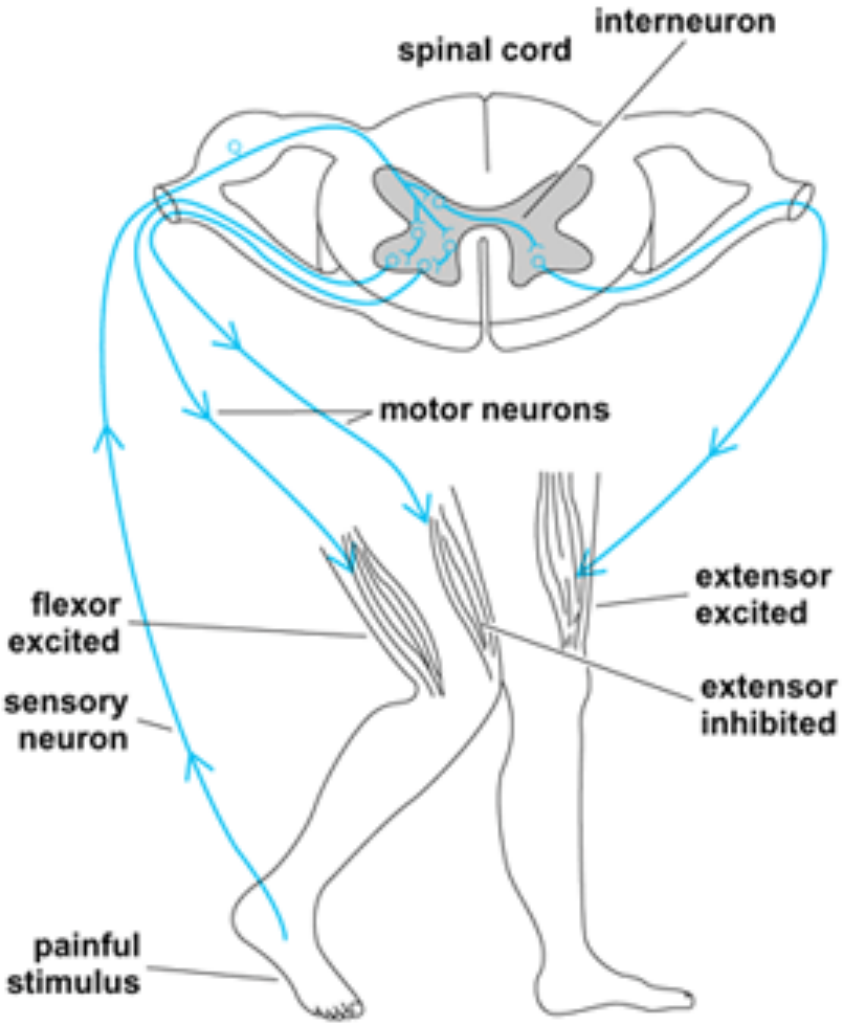
Polysynaptic Reflexes:50-80ms

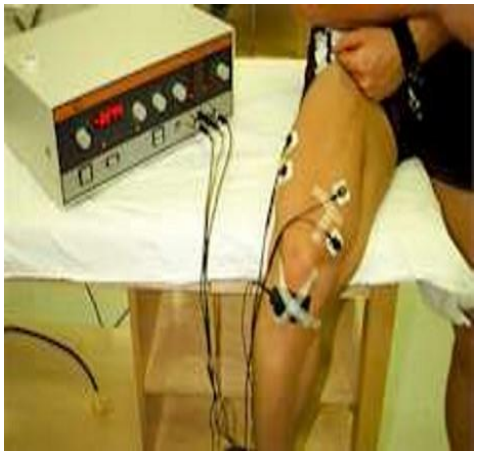


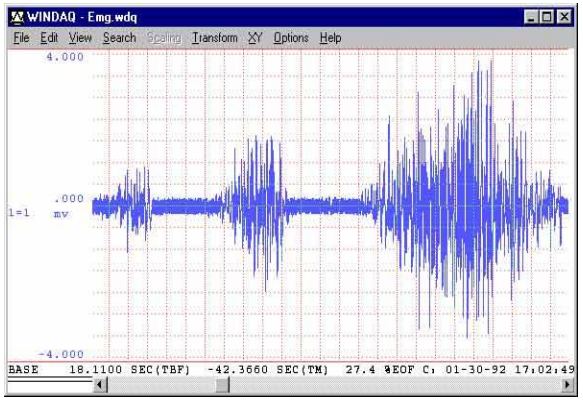
Latency of Response

- Latency of response refers to

time between the time the stimulus and muscle activation response

- This is measured through electronymyography
- The knee jerk reflex typically has a response latency of 40-80 msec.
- In laboratory session, you will use reaction time (RT) as an index for response latency





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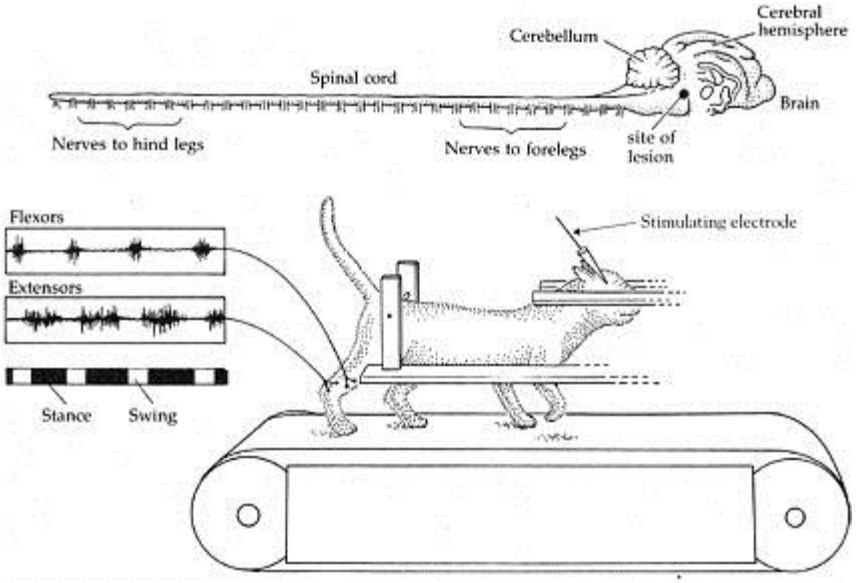
Sherrington's Chaining of Reflexes

- Sherrington's work was with cats/dogs/apes

- He argued that movements can be controlled at the level of the spinal cord through a chaining of reflexes

- Are all movements controlled this way?

- Can you think of examples to show it is not?



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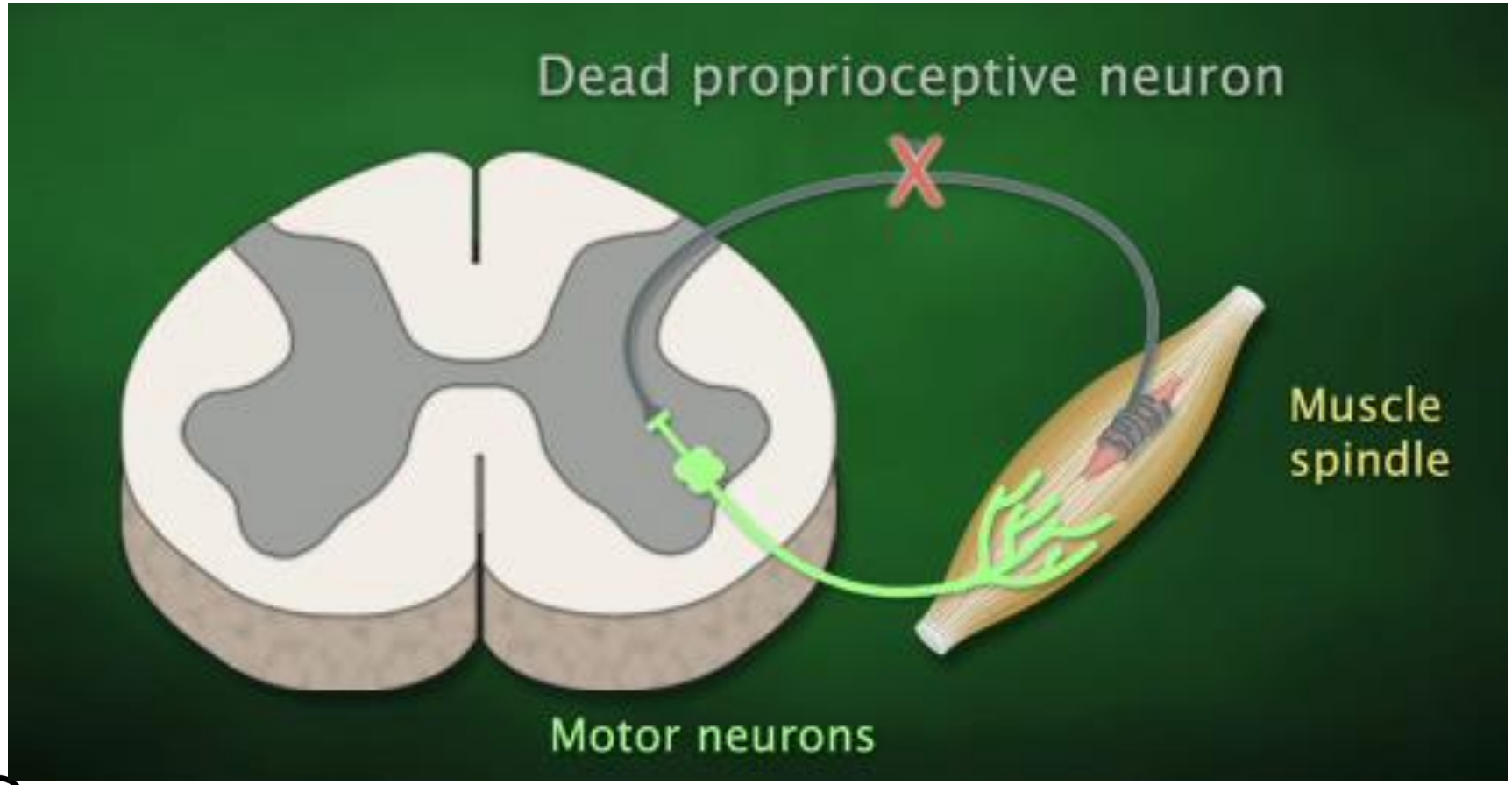
Limitations of Sherrington's Ideas

1. Voluntary movements can be activated without a stimulus triggering the movement

2. Research has shown that movements can occur in the absence of sensory input (Taub and Berman, 1968)

What if a Viral Infection Kills Proprioceptive Neurons?



Video

Researchers in SHK

- Limitations
  - Deafferentation in humans
  - Professor Yves Lajoie

  - Worked with a woman referred to as “GL”. GL had no sensory information concerning touch, tendon vibration and proprioception. GL was able to carry out her activities of daily living by relying on

Limitations of Sherrington's ideas

3. Cannot explain rapid movement sequences

4. A given stimulus can result in different responses depending on context and descending commands

5. Reflex chaining does not explain the ability to produce novel movements

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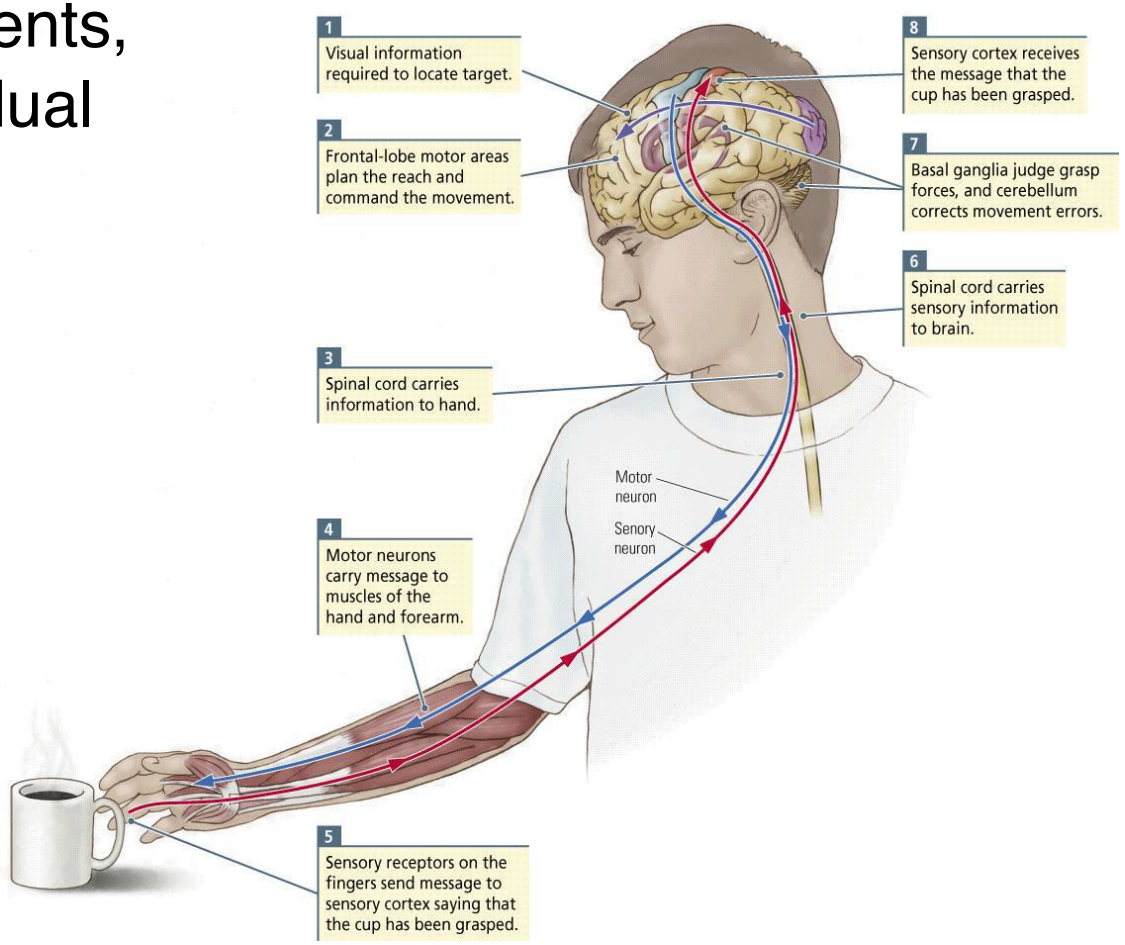
Voluntary movements

- Voluntary movements are goal directed movements, initiated by the individual



Voluntary Response Latency

- For voluntary movements, latency of response is about 120-180msec depending on the task and the circumstances

- Voluntary reactions require the person to pass through three stages of information processing and requires attention

- Response latency can be affected by several factors

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Comparisons

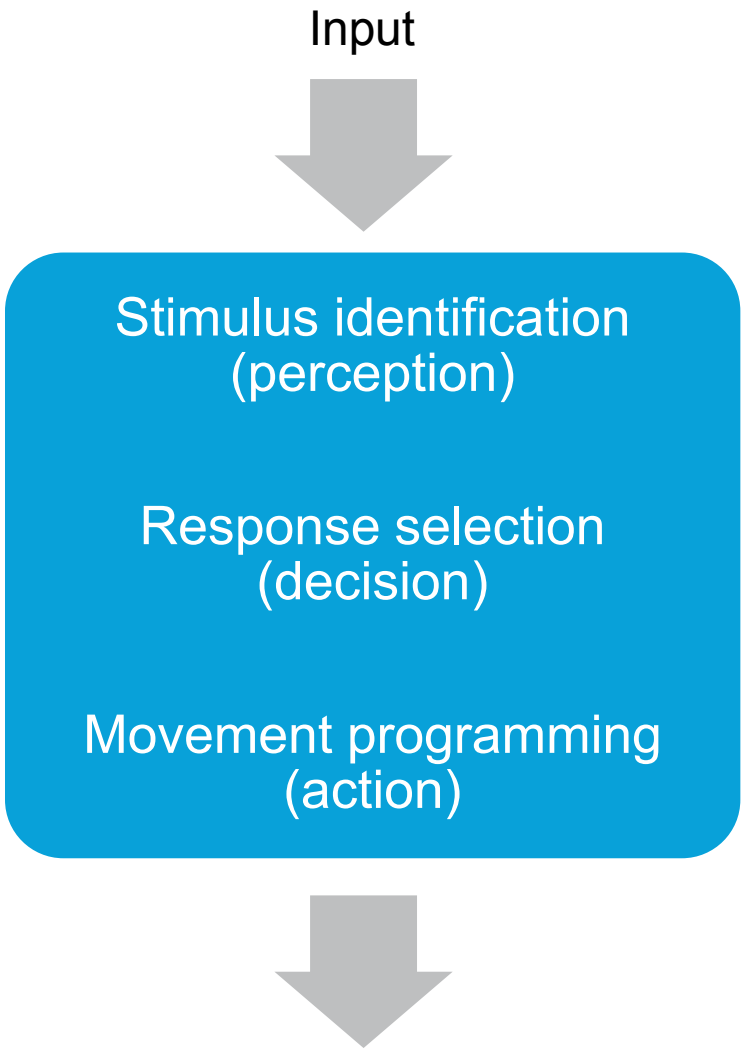
Reflex Movement

- Initiated by stimulus (involuntary)
- Requires no conscious attention or information processing
- Has a typical response latency of 40-80 msec

Voluntary Movement

- Initiated by intention
- Requires attention and information processing
- Has a typical response latency of 120-180 msec

Three Stages of Information Processing



Factors Influencing Reaction Time (RT)

- Number of S-R combinations

Hick's Law:

The time it takes to make a decision increases as the number of alternatives increases

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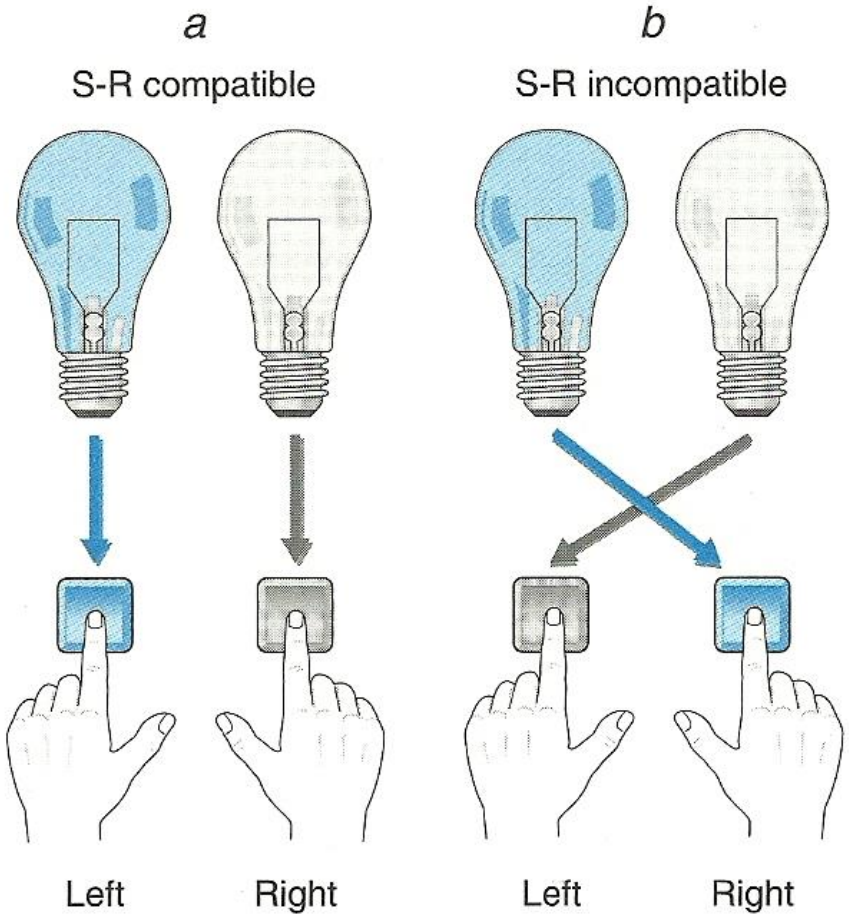
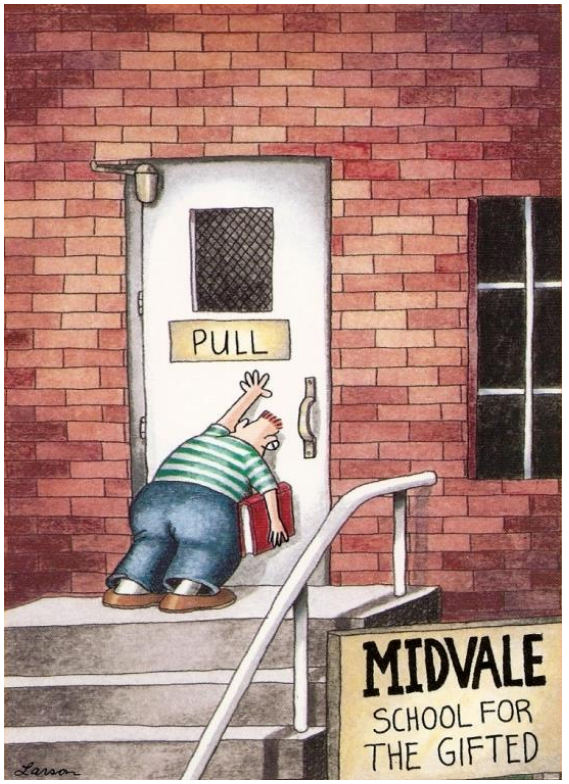
Factors Influencing RT

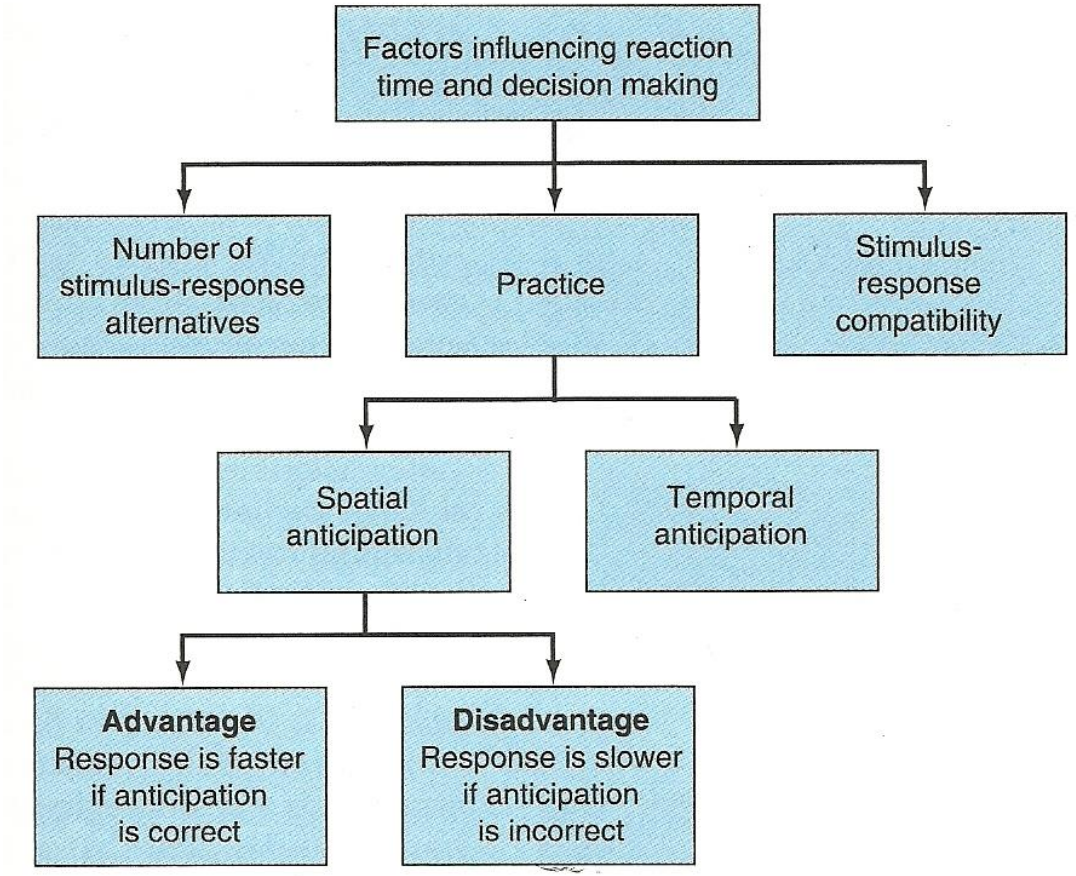
- S-R Compatibility





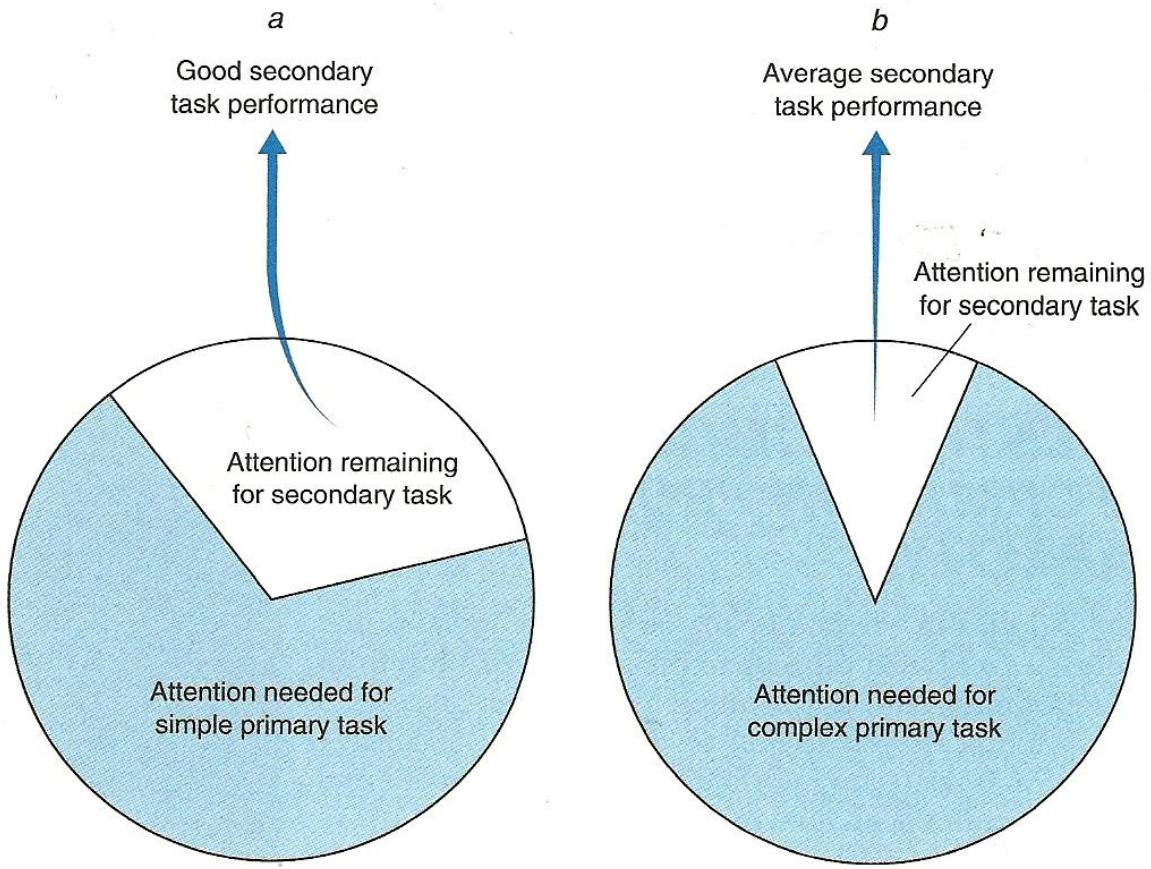
Factors Influencing RT

- number of S-R combinations
- S-R compatibility
- complexity
- practice
- timing uncertainty
- stimulus intensity
- age
- intelligence
- stress



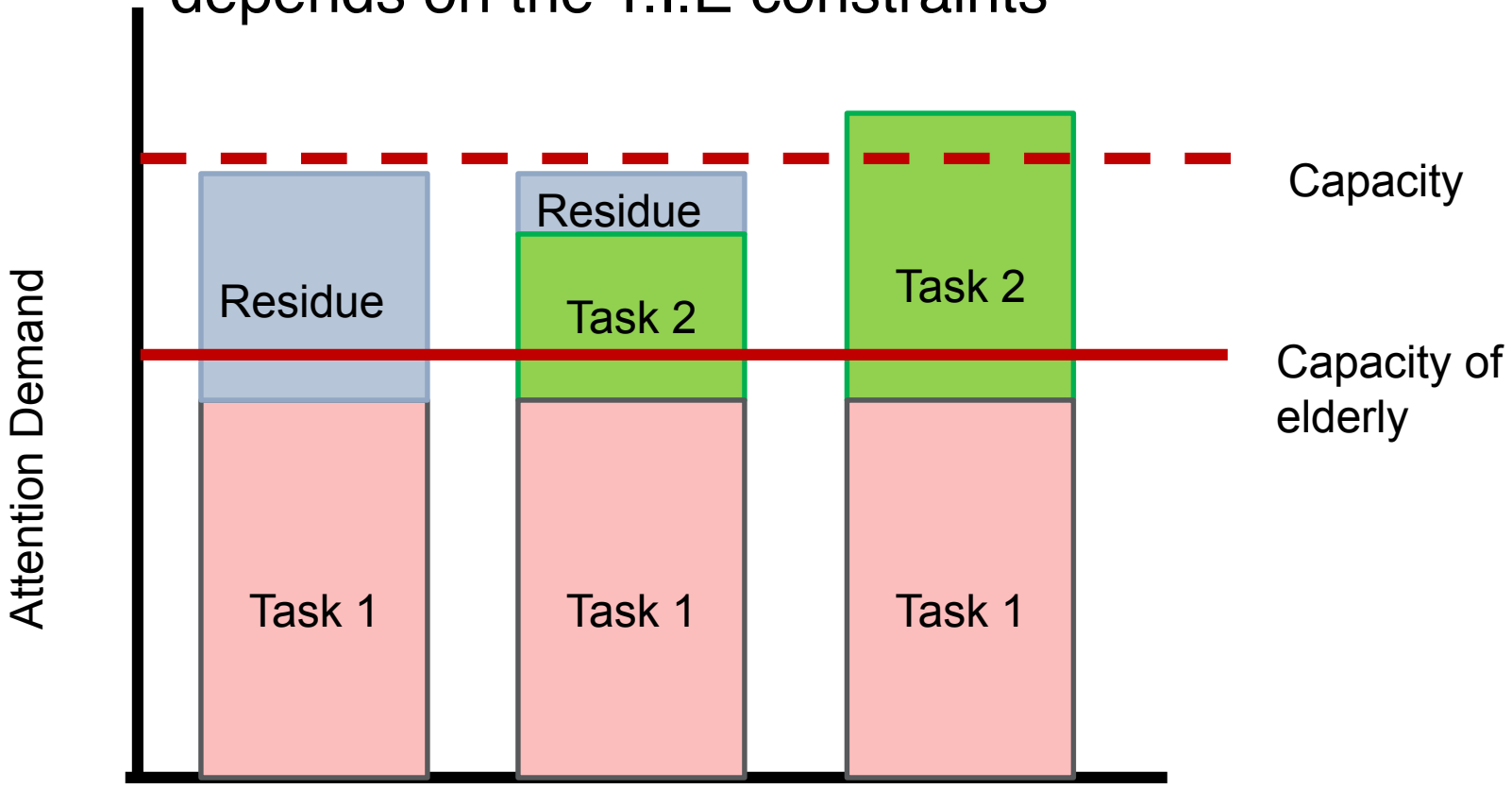
Attention

- Limitations in the Ability of Processing Information is limited in each individual



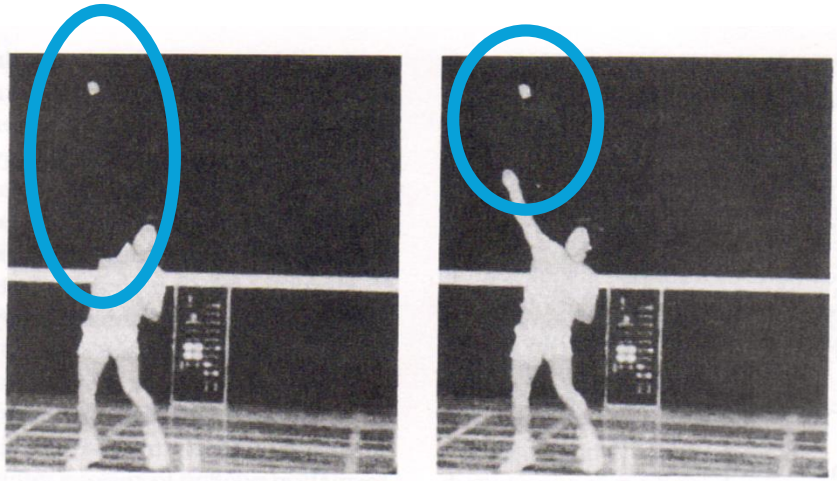
Limited Attention Capacity

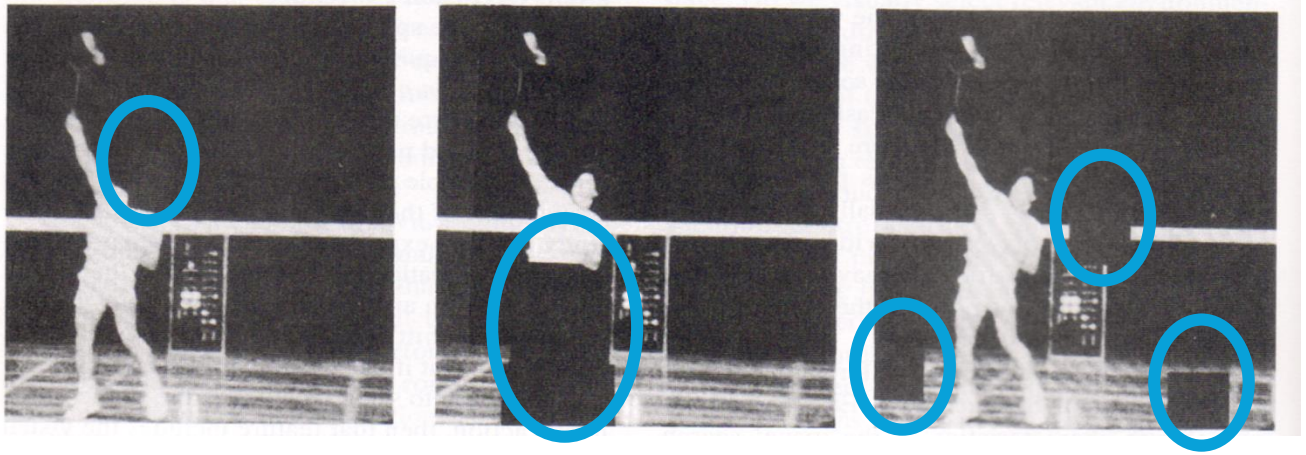
depends on the T.I.E constraints



Selective Attention

- Service de badminton
- Experts focus on the racket and the ball
- Novice focus on everything: surrounding



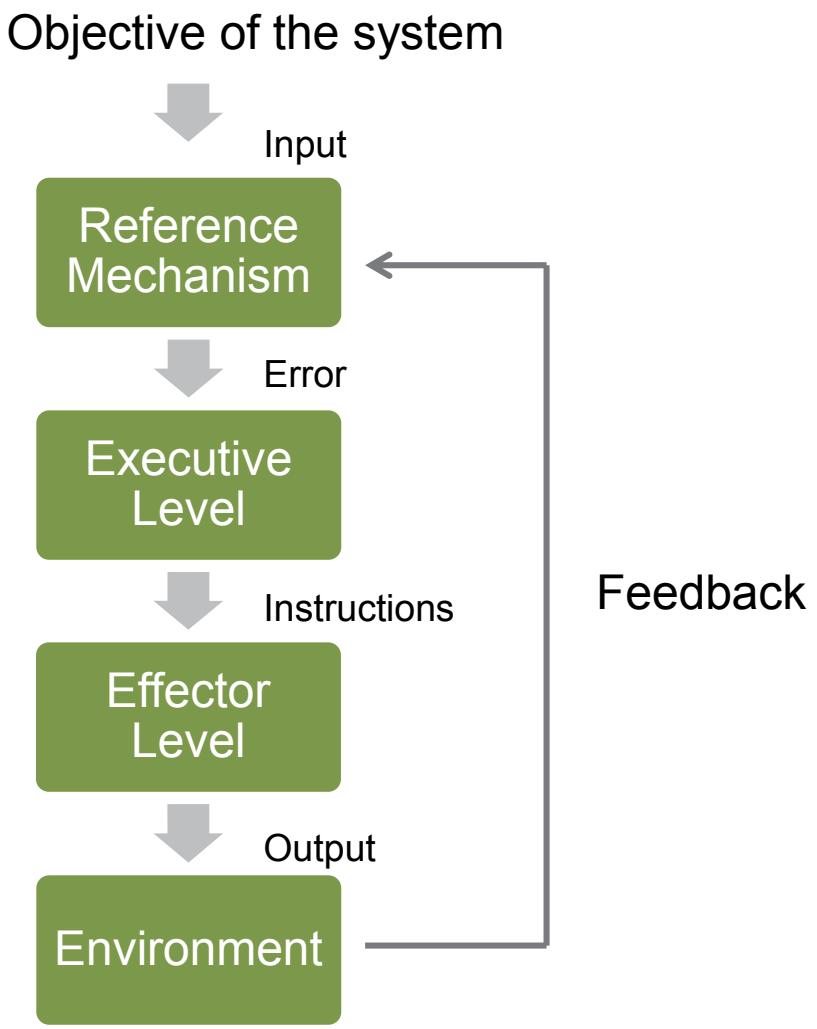


Two Types of Motor Control

1. A closed-loop system
   - Movement based on sensory feedback

I. Flexibility
II. Adaptability
III. Precision
IV. Slow

   - Example ? Throwing a ball



Two Types of Motor Control

2. Open-loop control system
   - Structured to move forward (feedforward)

I. Quick and powerful movements

II. Less effective in unstable situations because there's no error control

- Example ?