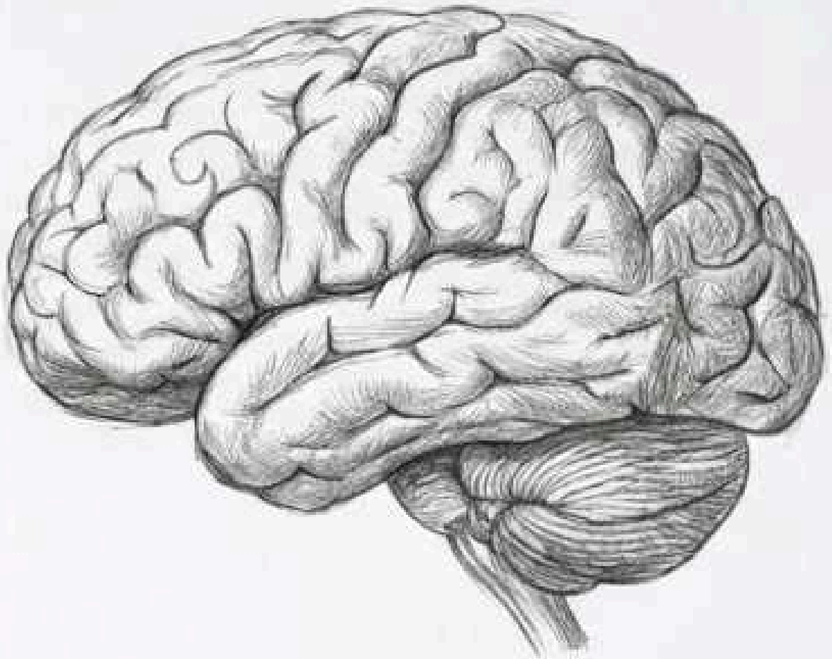
¶ 5.1

Movement, Emotion, and Language: How the Brain Is Organized



Gemini Notebook



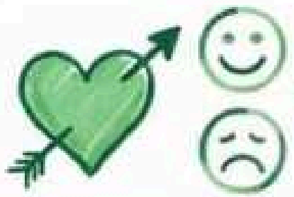
Patients/Injuries

Movement

Movement



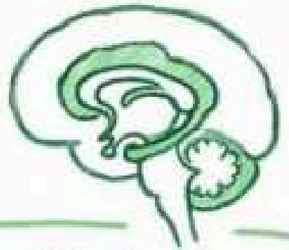
The Motor System



Emotion Regulators

Emotion

Emotion



Living Brain Imaging



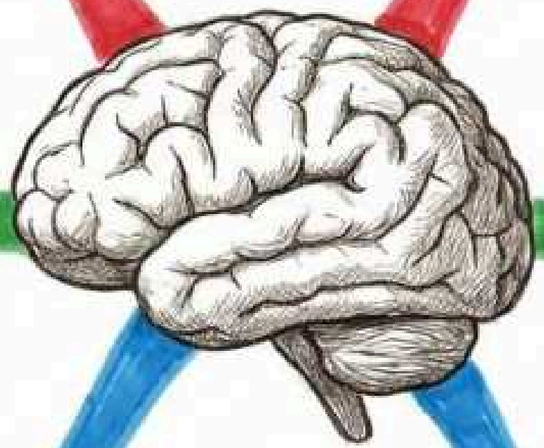
Patients/Injuries

Language

Language

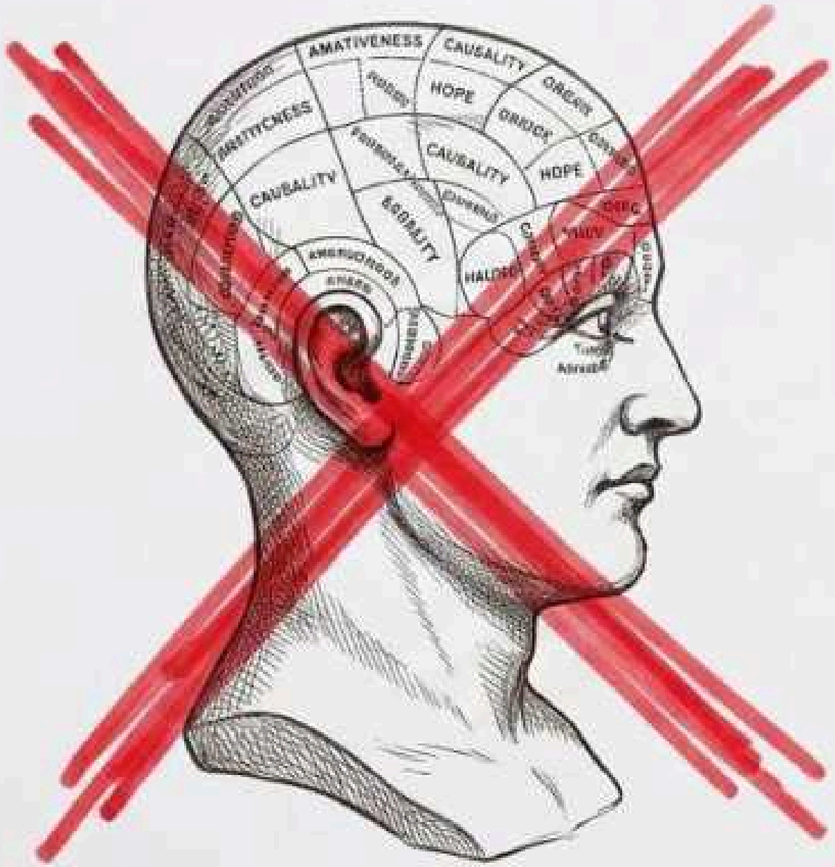


Living Brain Imaging



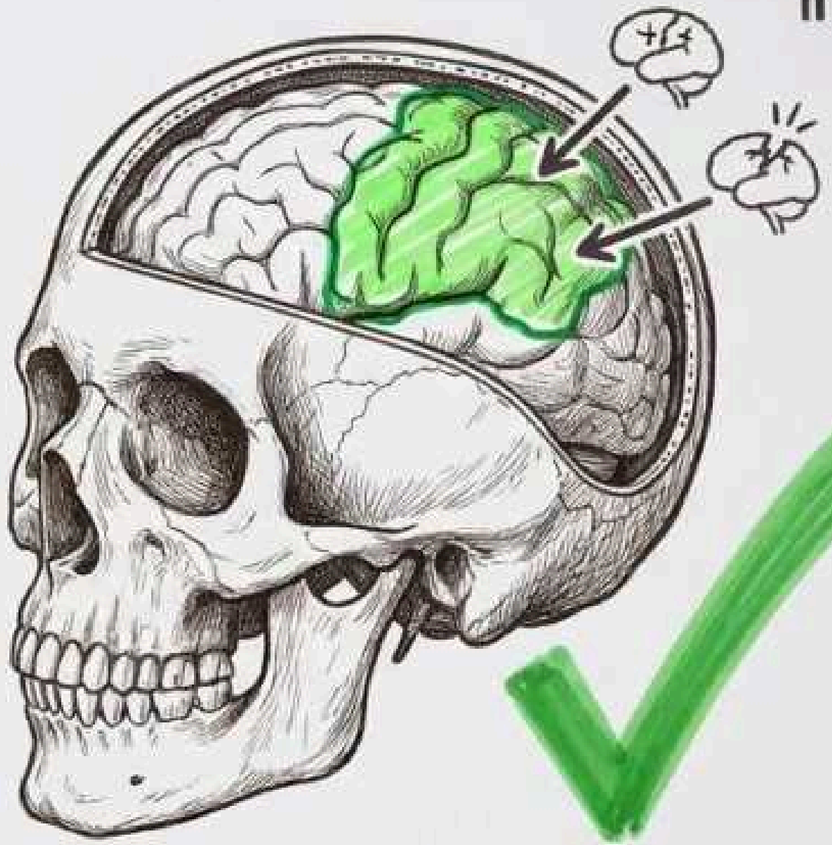
Each region contributes, but none works alone.

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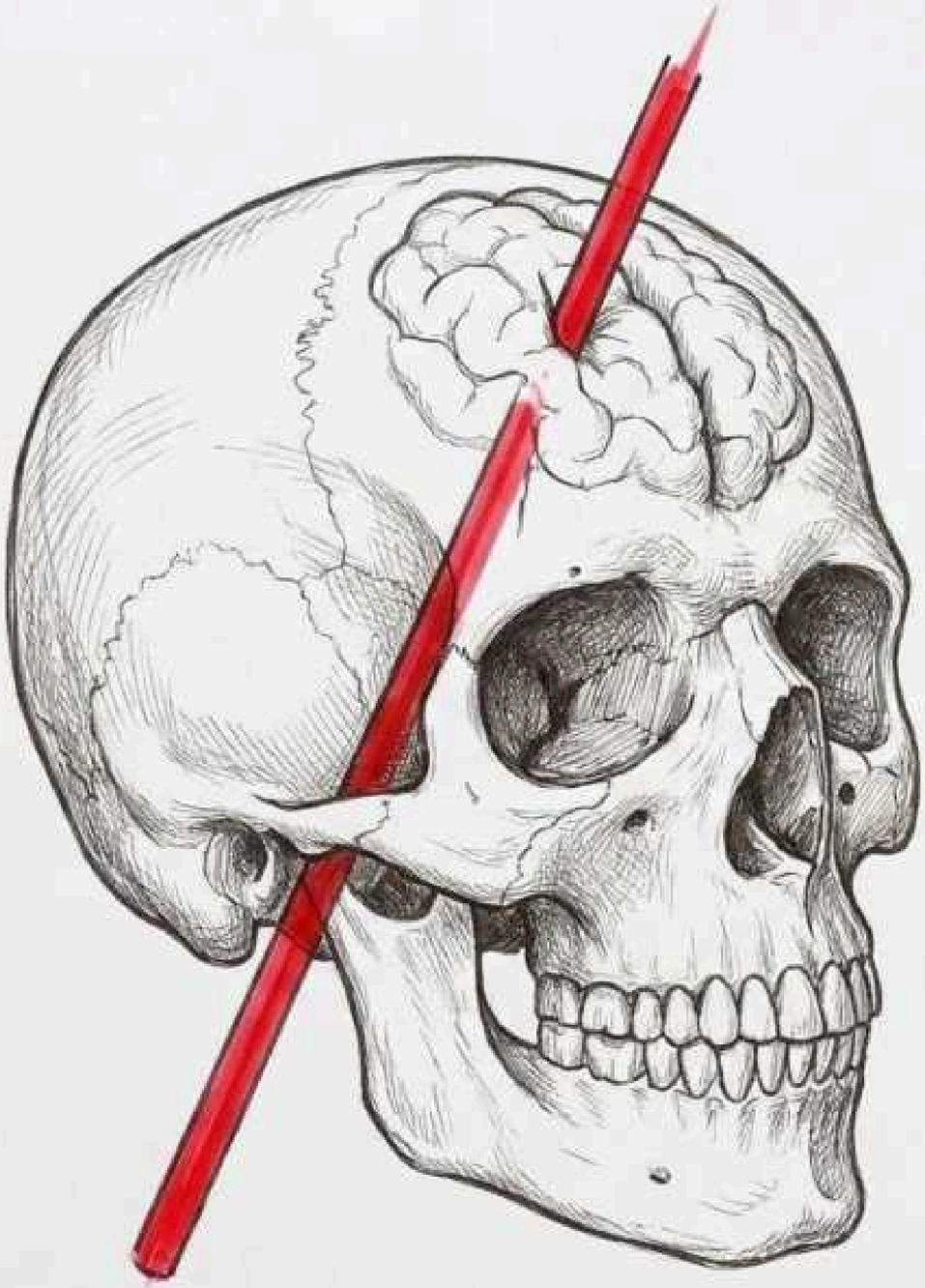
Franz Gall, early 19th Century

- Phrenology: Skull shape reveals faculties. (INCORRECT: Skull bumps reveal nothing).



Localization of Function: Brain injuries reveal that specific regions perform specific jobs. (CORRECT: But the details are subtle).

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Year: 1848

Rod Length: ≈ 1m

Rod Mass: 6kg

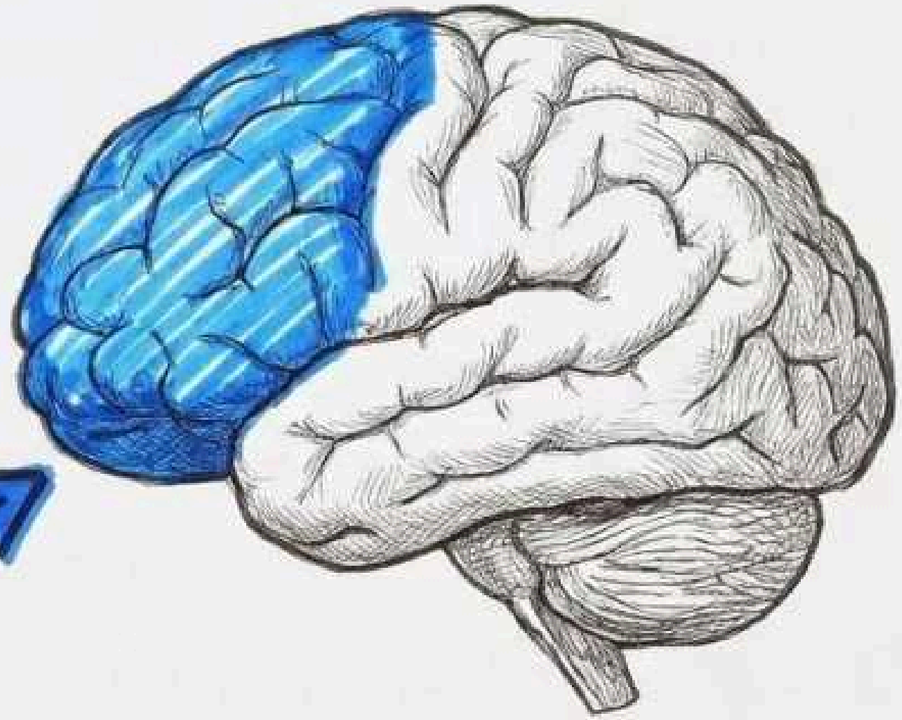
Clinical Outcome:
Survived, retained ability to walk and talk, but suffered a fundamental change in character.

Gemini Notebook

The Prefrontal Cortex (Executive Function)

¶ 5.5

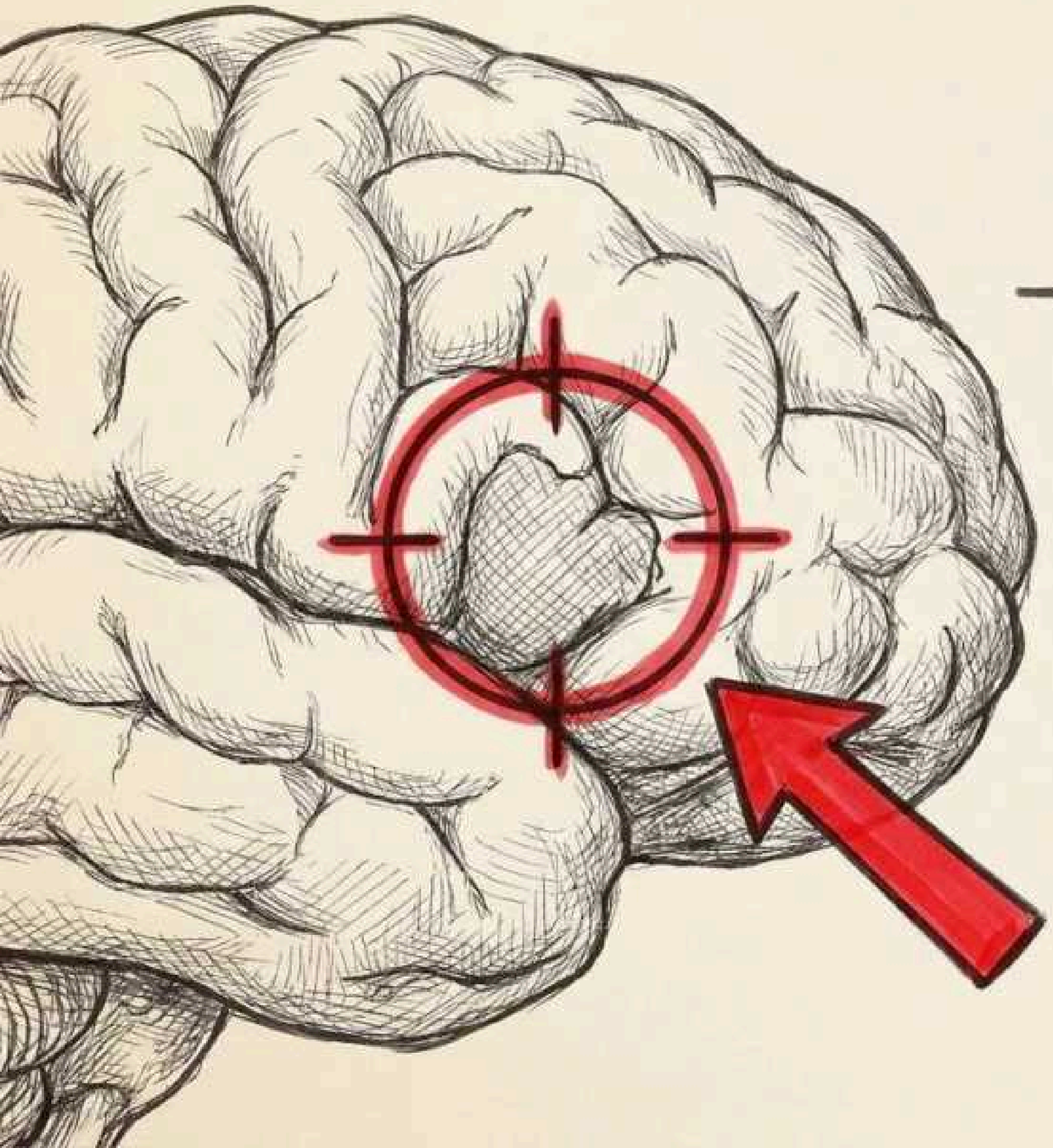
Maturation Timeline:
Continues developing into the mid-20s.
into the mid-20s.



$$\text{Behavior} = \left(\boxed{\text{Working Memory}} + \boxed{\text{Long-Term Goals}}\right) - \boxed{\text{Immediate Impulses}}$$

Damage disrupts behavior and self-control while leaving raw intelligence intact.

Gemini Notebook



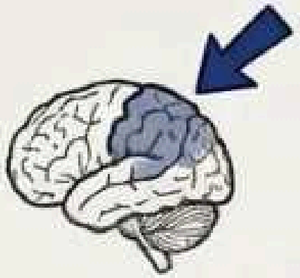
Historical Marker:
1861, Physician Paul Broca

Patient Profile:
Tan

Observation:
Could understand speech perfectly. Production limited to one single syllable ("Tan").

Conclusion: The highlighted region (Broca's Area) is essential for producing speech.

Gemini Notebook



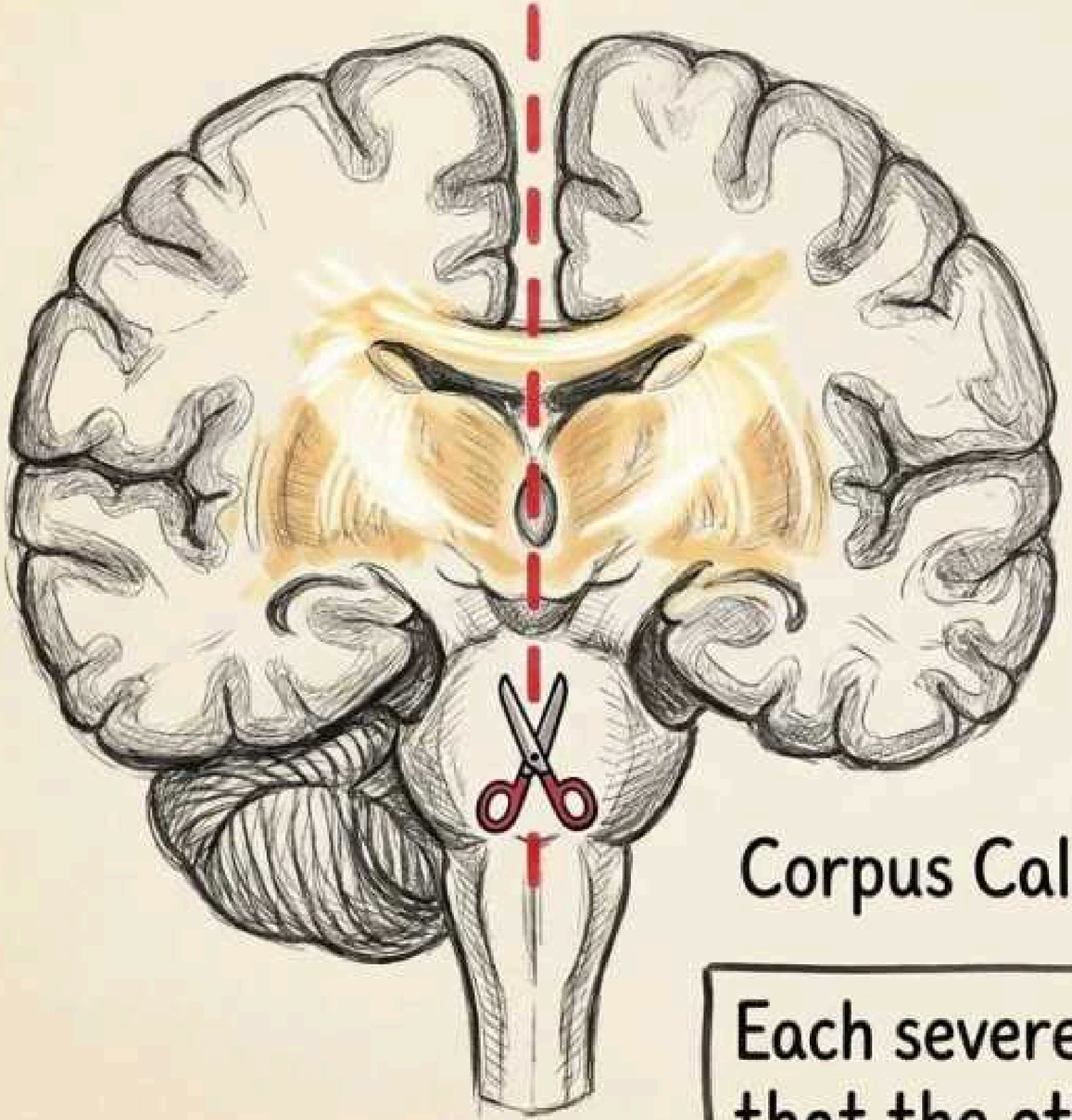
Language depends mainly on the left hemisphere (in most right-handed and many left-handed people).

Condition	Location	Speech Production	Comprehension
Broca's Aphasia	Left Frontal Lobe	Halting, effortful	Intact
Wernicke's Aphasia	Left Temporal Lobe	Fluent, but nonsensical	Lost

Gemini Notebook

¶ 5.8

The Split-Brain Phenomenon (1960s, Sperry & Gazzaniga; 1981 Nobel Prize)

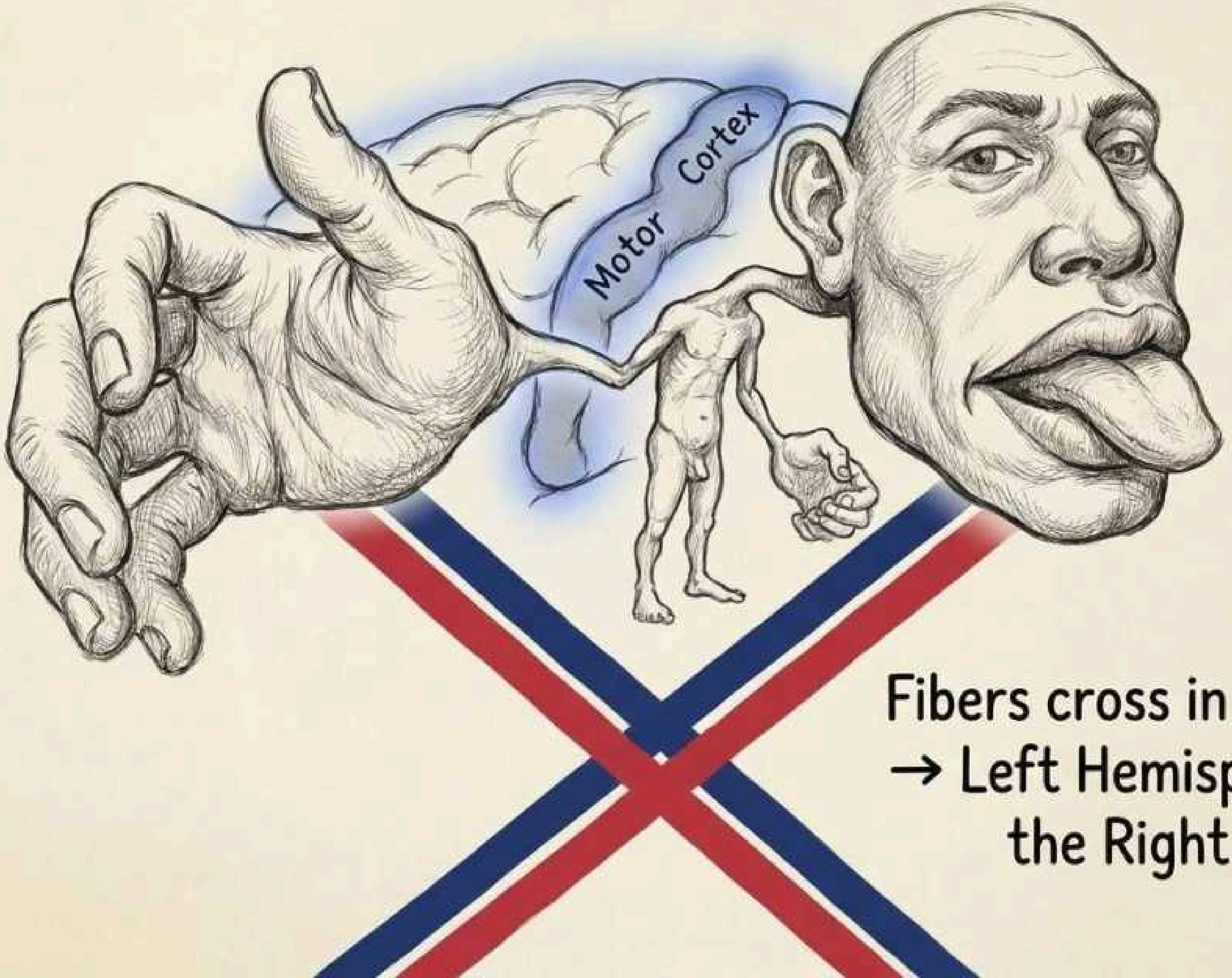


Corpus Callosum = Data Bridge ≈ 2×10^8 Axons

Each severed hemisphere can possess knowledge that the other hemisphere does not.

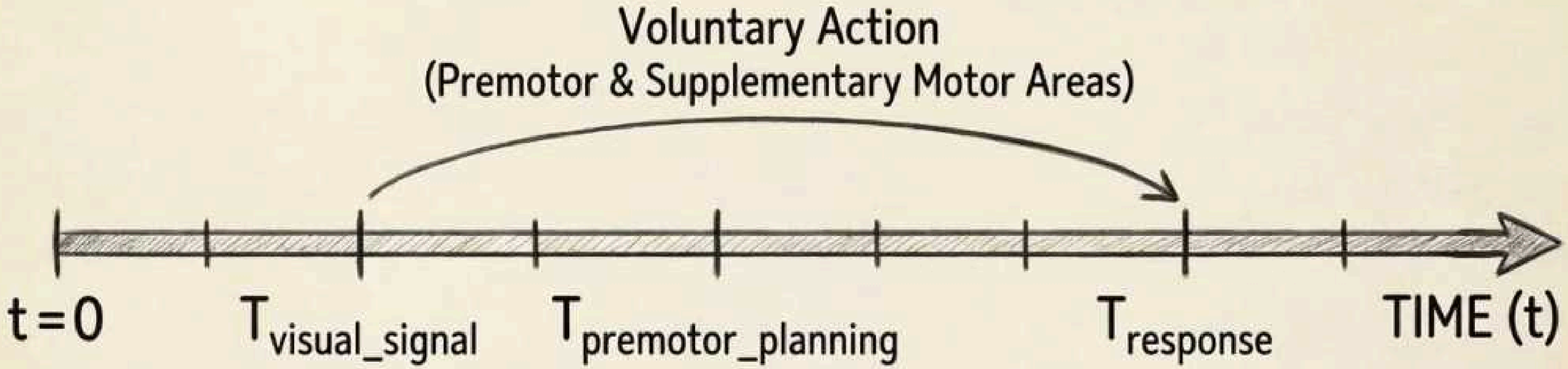
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¶ 5.9



Fibers cross in the medulla
→ Left Hemisphere moves
the Right Body.

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$T_{visual_signal} \rightarrow T_{response} \approx 250ms$

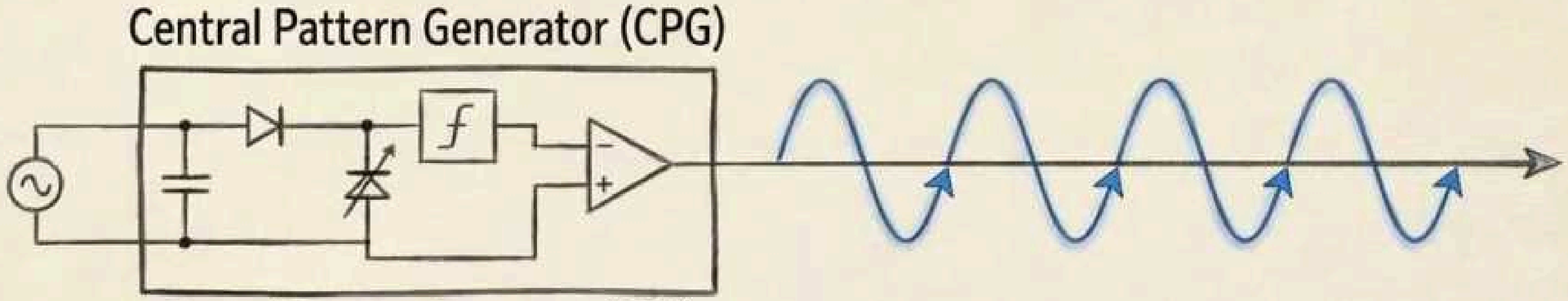
The Sprinting Rule

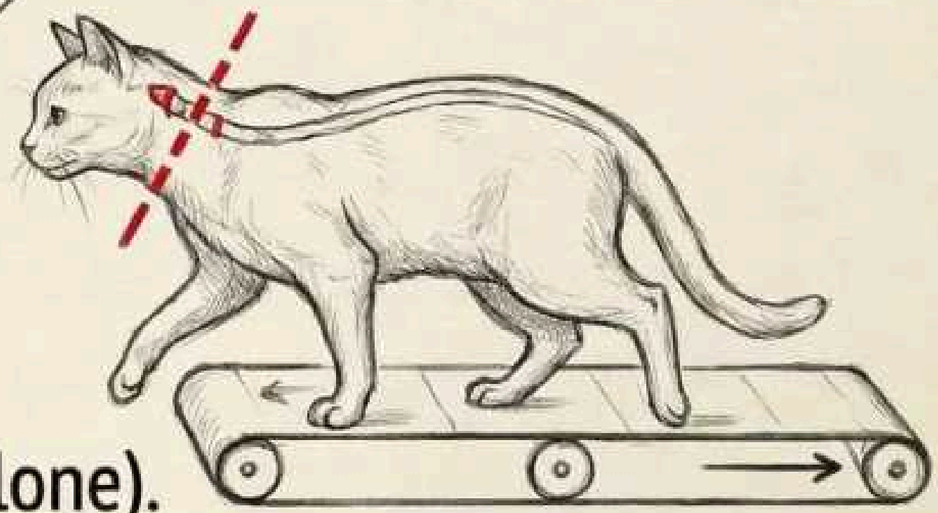
If $t_{start} < 100ms$ after the gun → False Start.
(Because no human nervous system can process and react faster).

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Spinal Independence: Some movements need no brain at all.

¶ 5.11

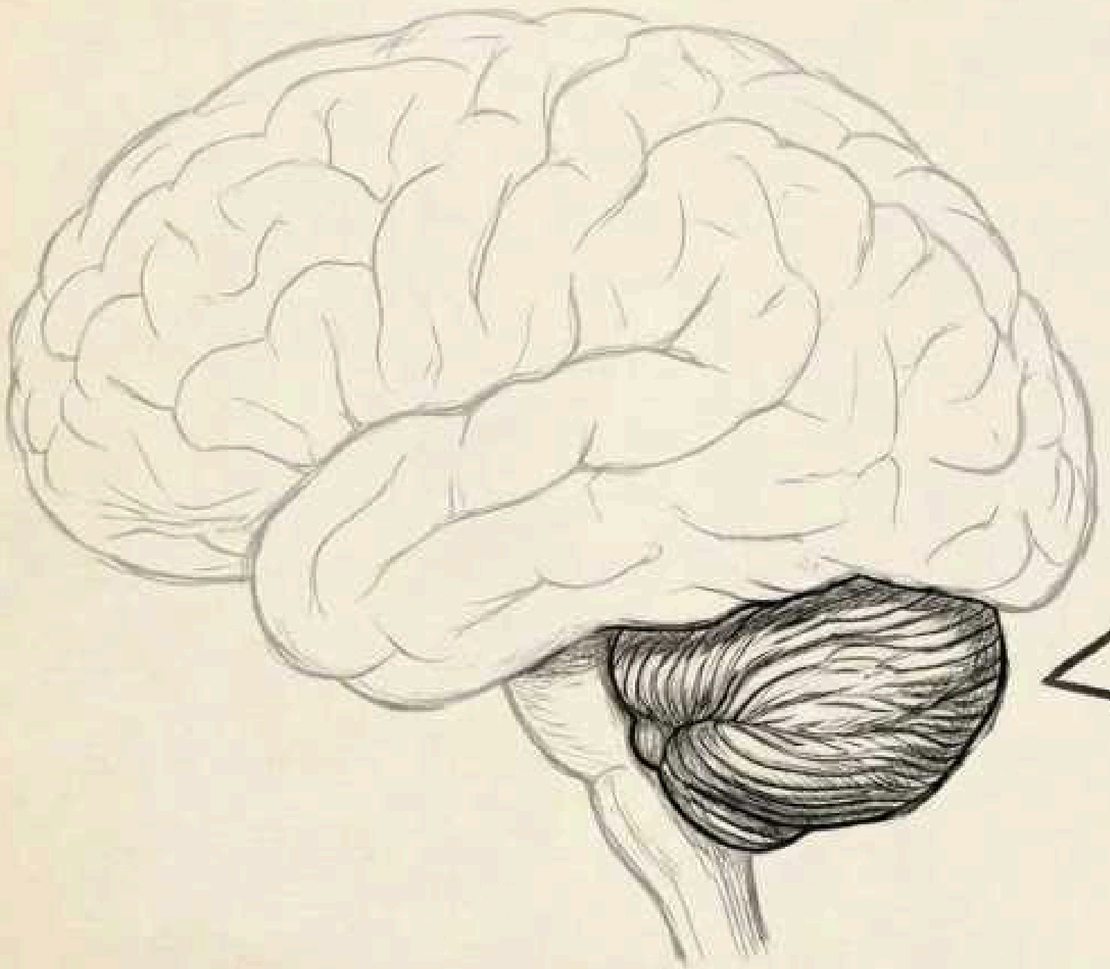




Examples: Knee-jerk reflex (spinal cord alone).

Brain = Starts, Stops, Steers.
Spinal Cord = Supplies the rhythm (walking/stepping).

Gemini Notebook



The Math of the Cerebellum

$$V_{cerebellum} \approx 0.1\, V_{total_brain}$$

$$N_{cerebellum} > 0.8\, N_{total_neurons}$$

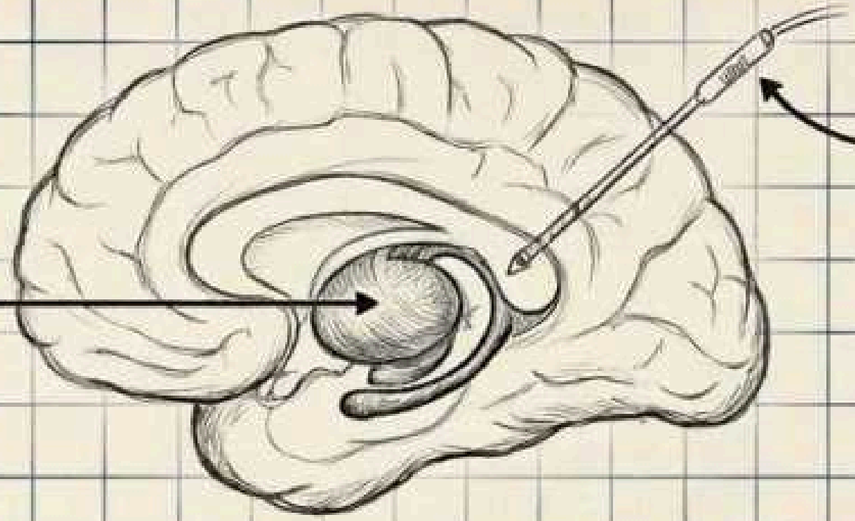
Function List

- Coordinates movement, precisely times actions, compares intent vs. feedback (error correction, e.g., riding a bicycle).

Pathology Note

Ataxia: Damage results in clumsy, shaky, poorly aimed movements.

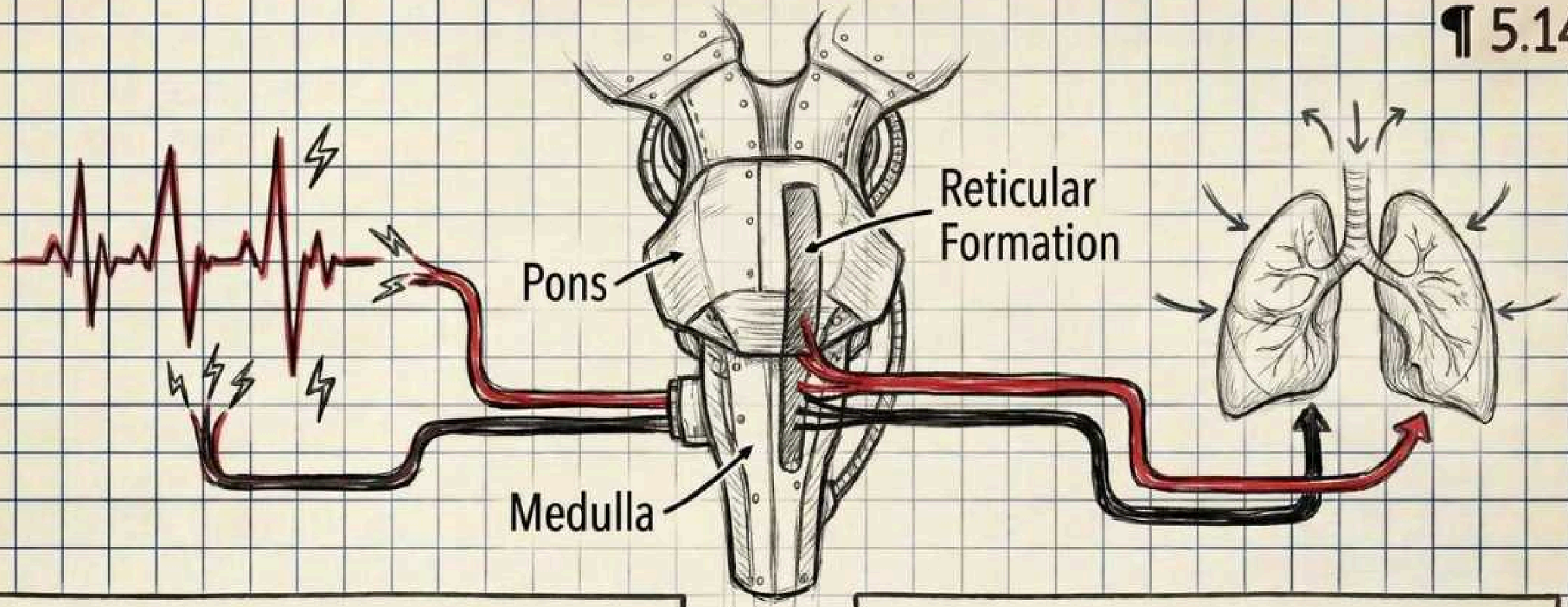
Gemini Notebook



Basal Ganglia Core Function: Select actions + Suppress competing actions.

Parkinson's Disease	Huntington's Disease
Dopamine supply ↓	Circuit degeneration
Hard to start movements	Unwanted, jerky movements
Rigid muscles	
Treatment note: Deep Brain Stimulation (electrical pulses) relieves tremors.	

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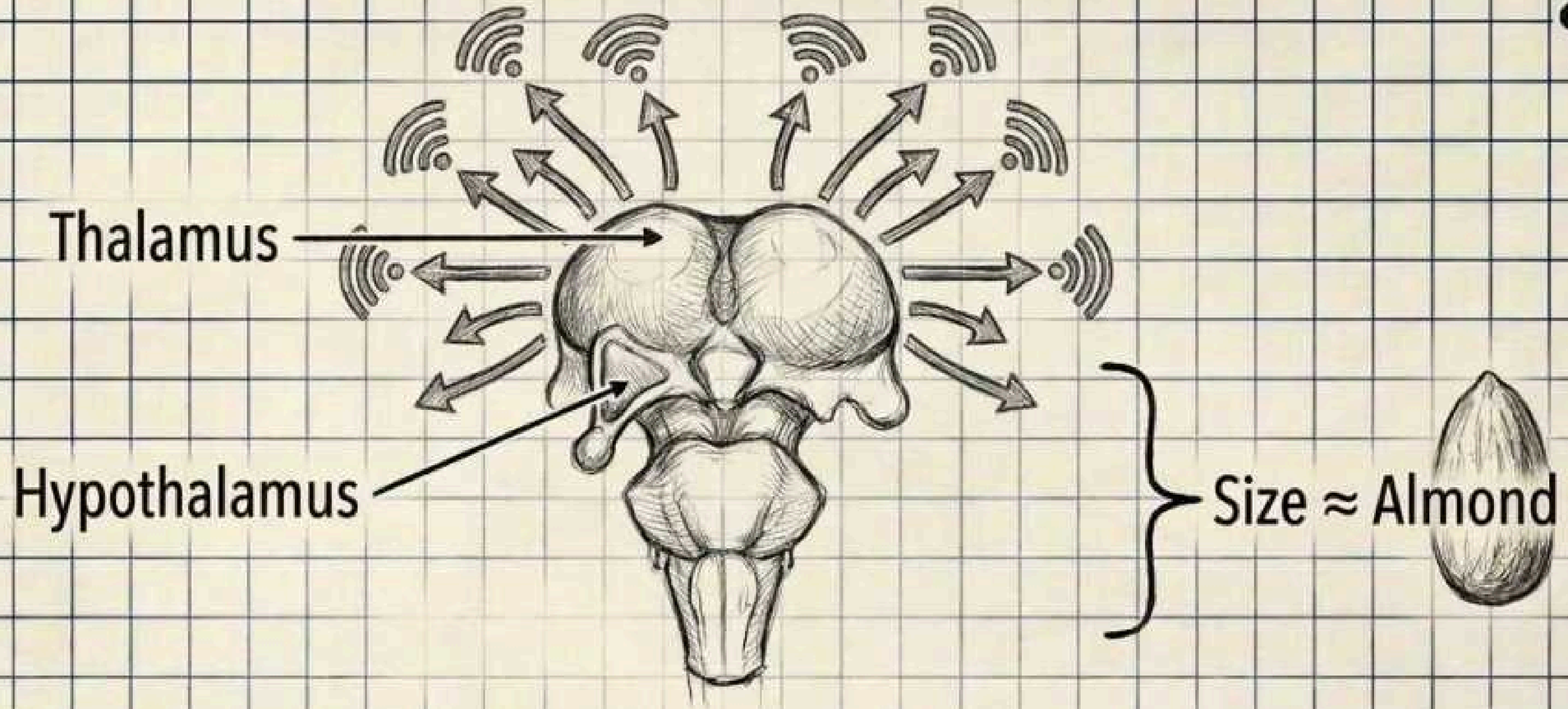


Medulla & Pons: Regulate breathing, heart rate, blood pressure.

Reticular Formation: Controls arousal and wakefulness (damage = coma).

Neurological Death = Irreversible loss of ALL brain function, importantly including the brainstem, not just the cortex.

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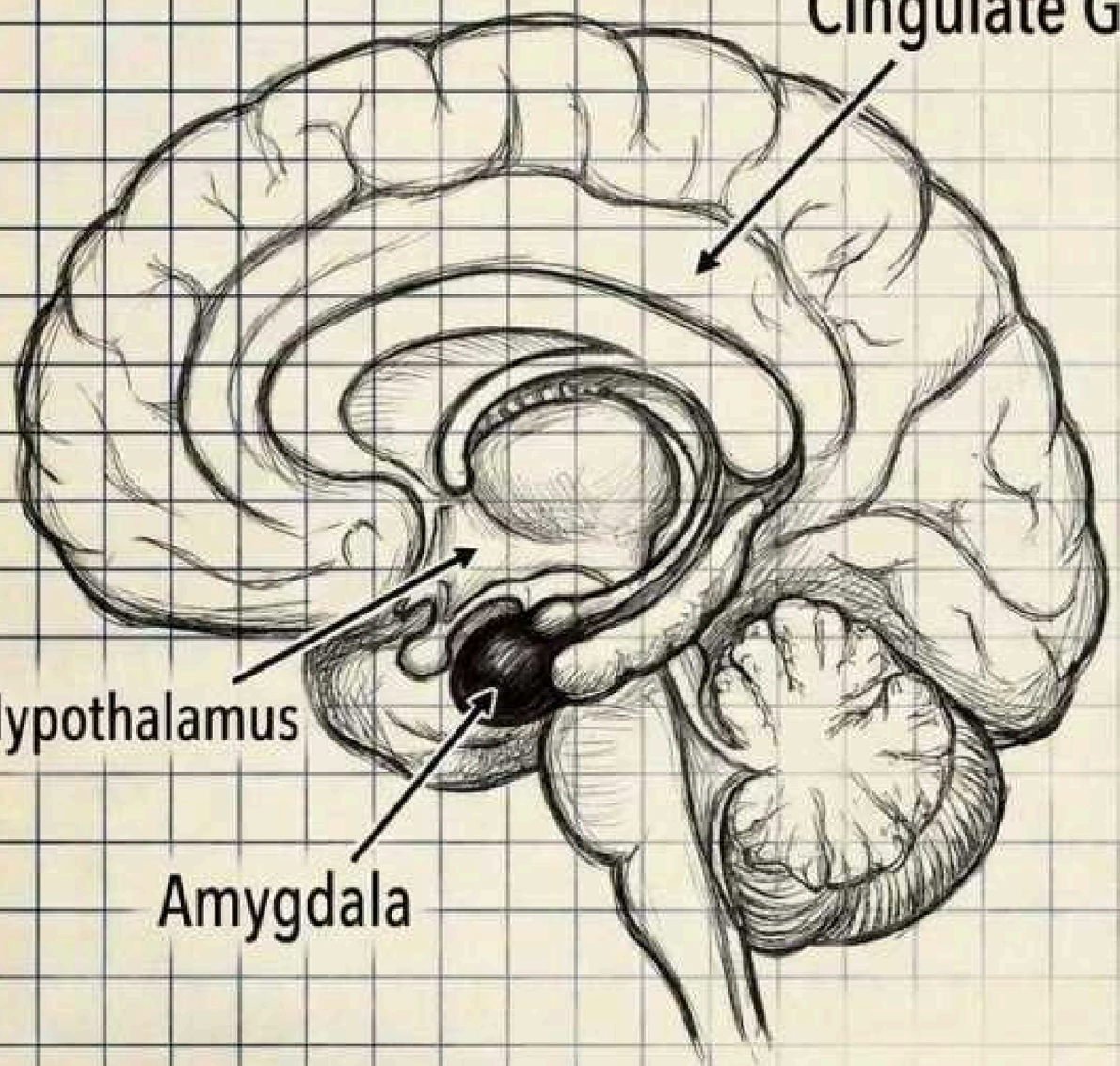


Thalamus (The Router):
Relay station sending nearly all sensory info to the correct cortical region.

Hypothalamus (The Thermostat):
Regulates homeostasis (body temperature, hunger, thirst, sleep). Controls the pituitary gland (hormone release into blood).

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¶ 5.16



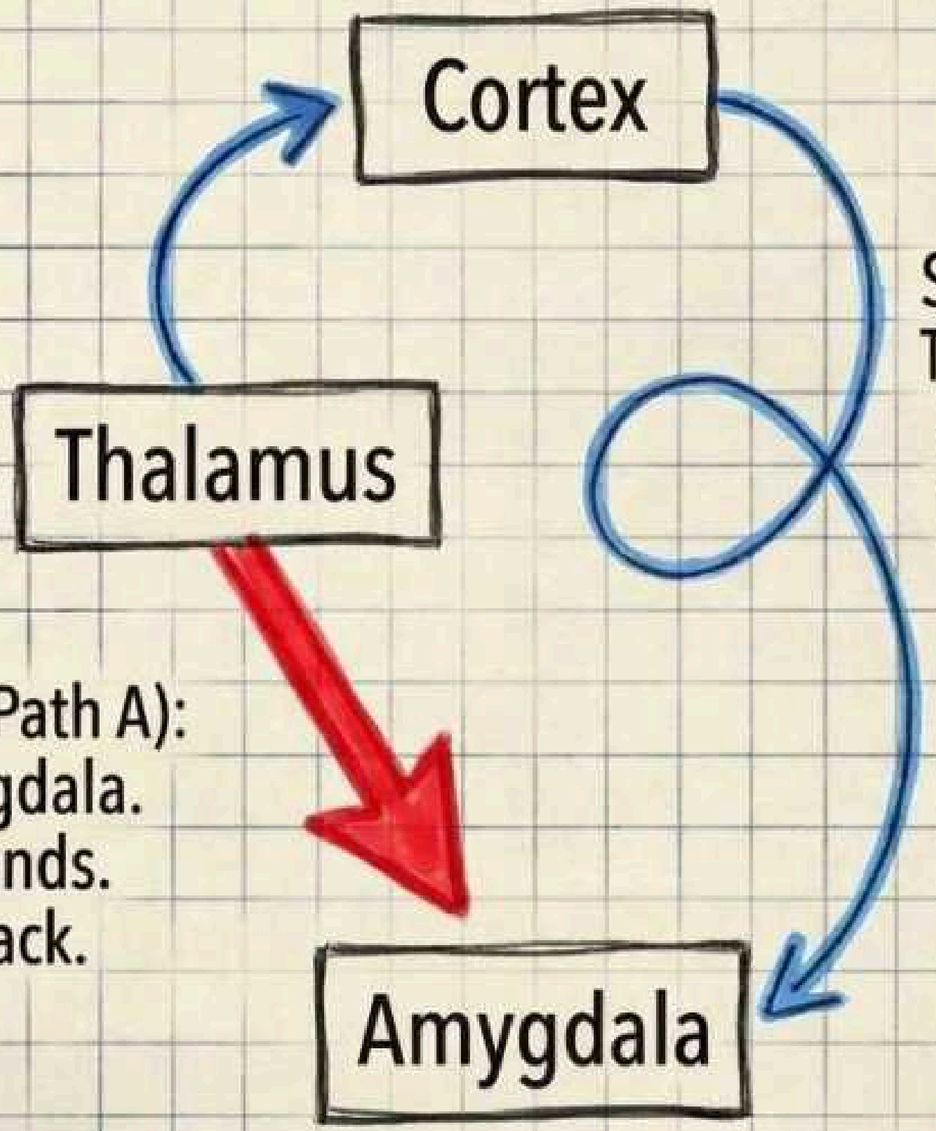


Role: Central to the emotion of fear.
Case Study: Patient S.M.
Condition: Amygdalae destroyed by disease.
Observation: Capable of intellectually stating snakes/spiders are dangerous, but physiological Fear Response = 0.

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The Dual-Routing of Fear (LeDoux)

¶ 5.17



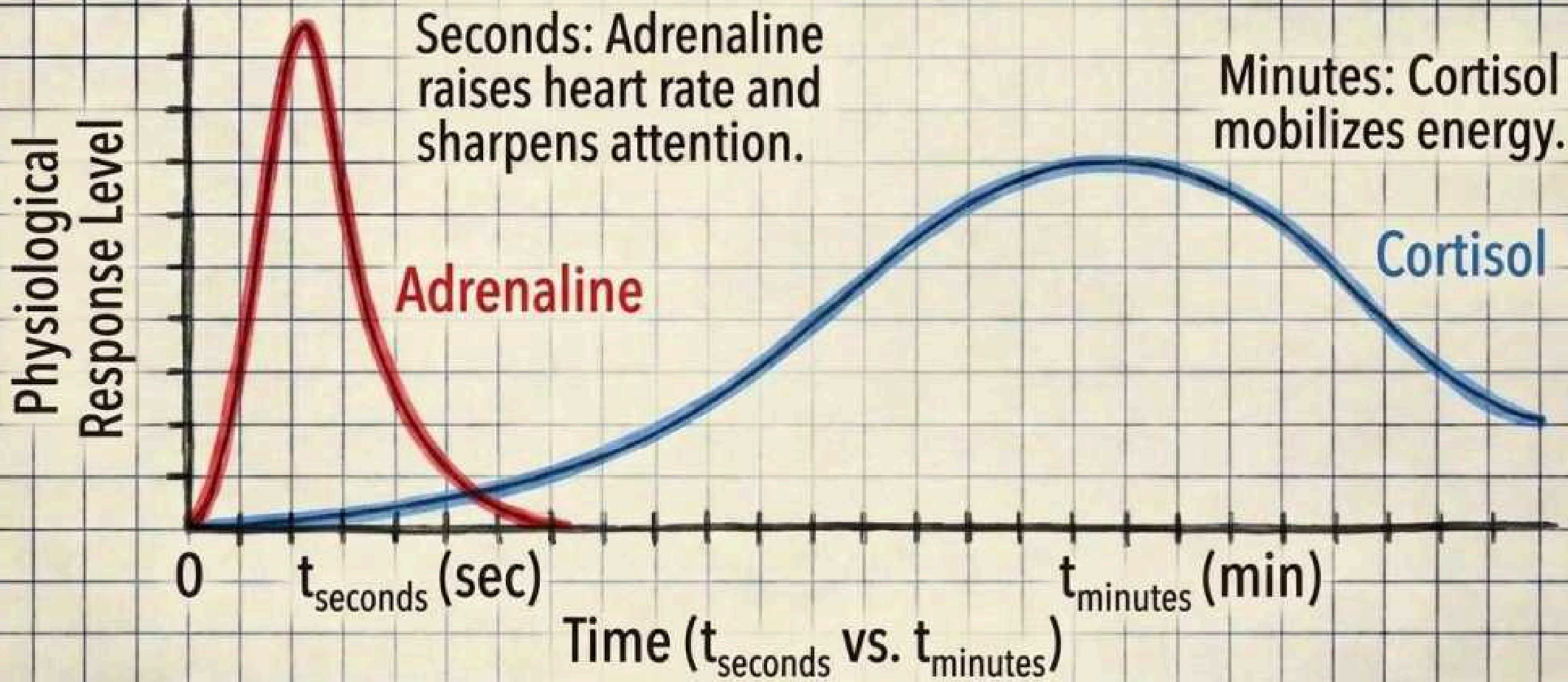
Slow/Detailed Route (Path B):
Thalamus → Cortex → Amygdala.
Action: Detailed analysis
("It's just a stick, not a snake").

Fast/Rough Route (Path A):
Thalamus → Amygdala.
Time = milliseconds.
Action: Jump back.

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¶ 5.18

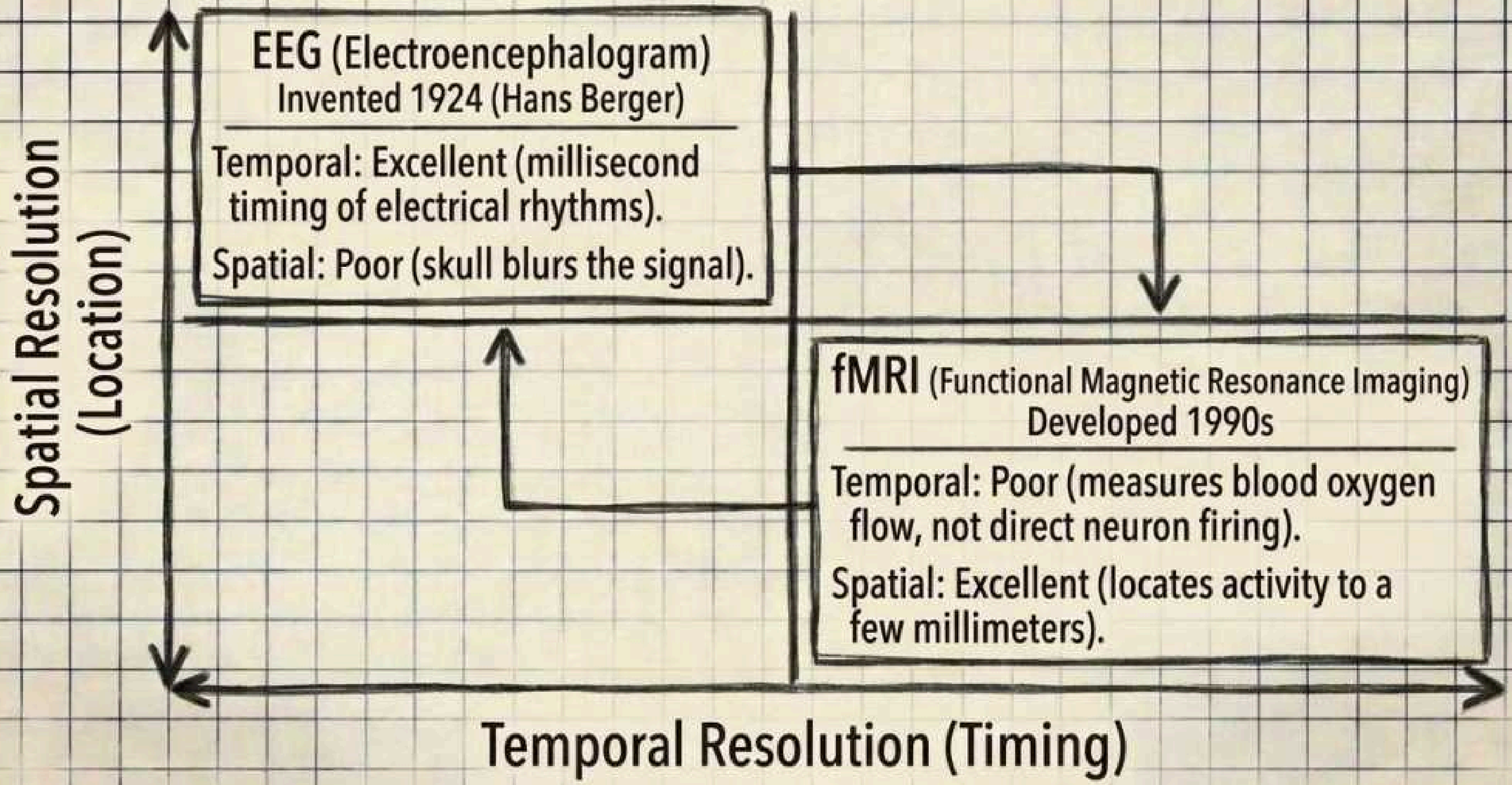
Amygdala signals Hypothalamus → Activates Sympathetic Nervous System.



Useful in short bursts; harmful when chronic.

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Trade-offs in Brain Imaging



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CLINICAL TEST

Patient A Profile

Speaks slowly/with great effort, uses few words.

Understands everything said to her.

Patient B Profile

Speaks fluently but produces nonsense.

Understands nothing.

? Based on the findings of Broca and Wernicke, which language area is damaged in each patient?

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Looking Ahead to Lecture 6: The Changing Brain

Neuroplasticity + Learning + Memory + Sleep

How does the brain change with experience?

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