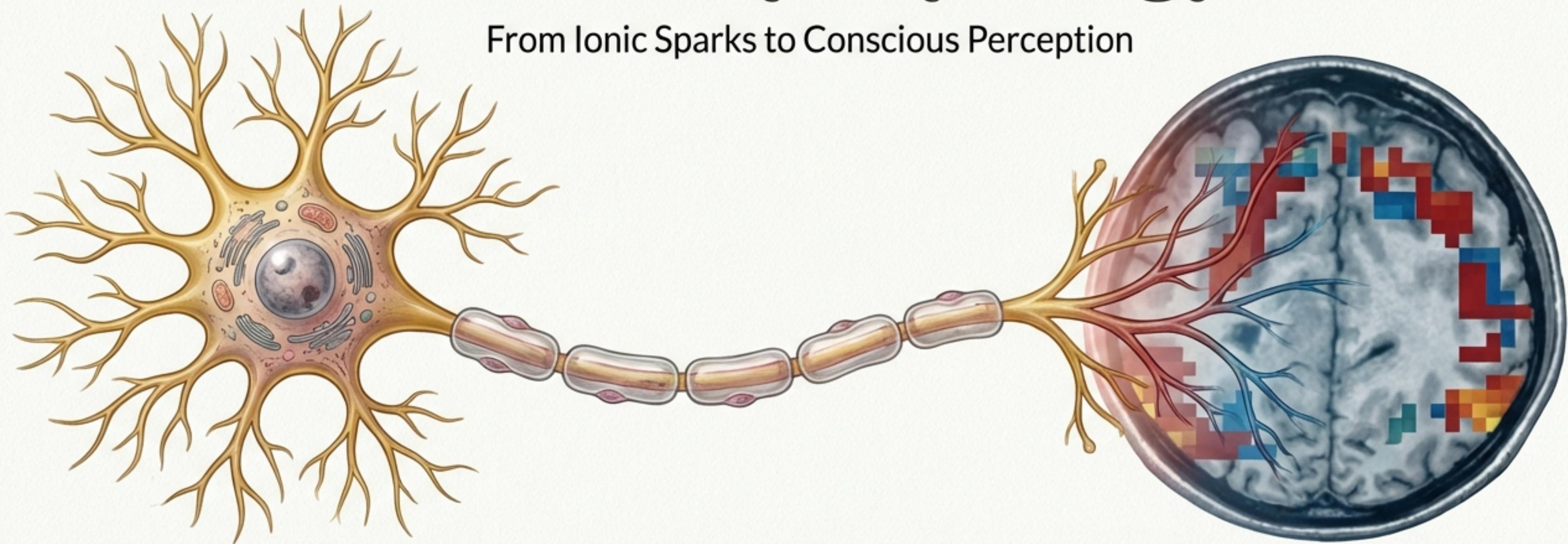


# The Scenic Route: Principles of Sensory Physiology

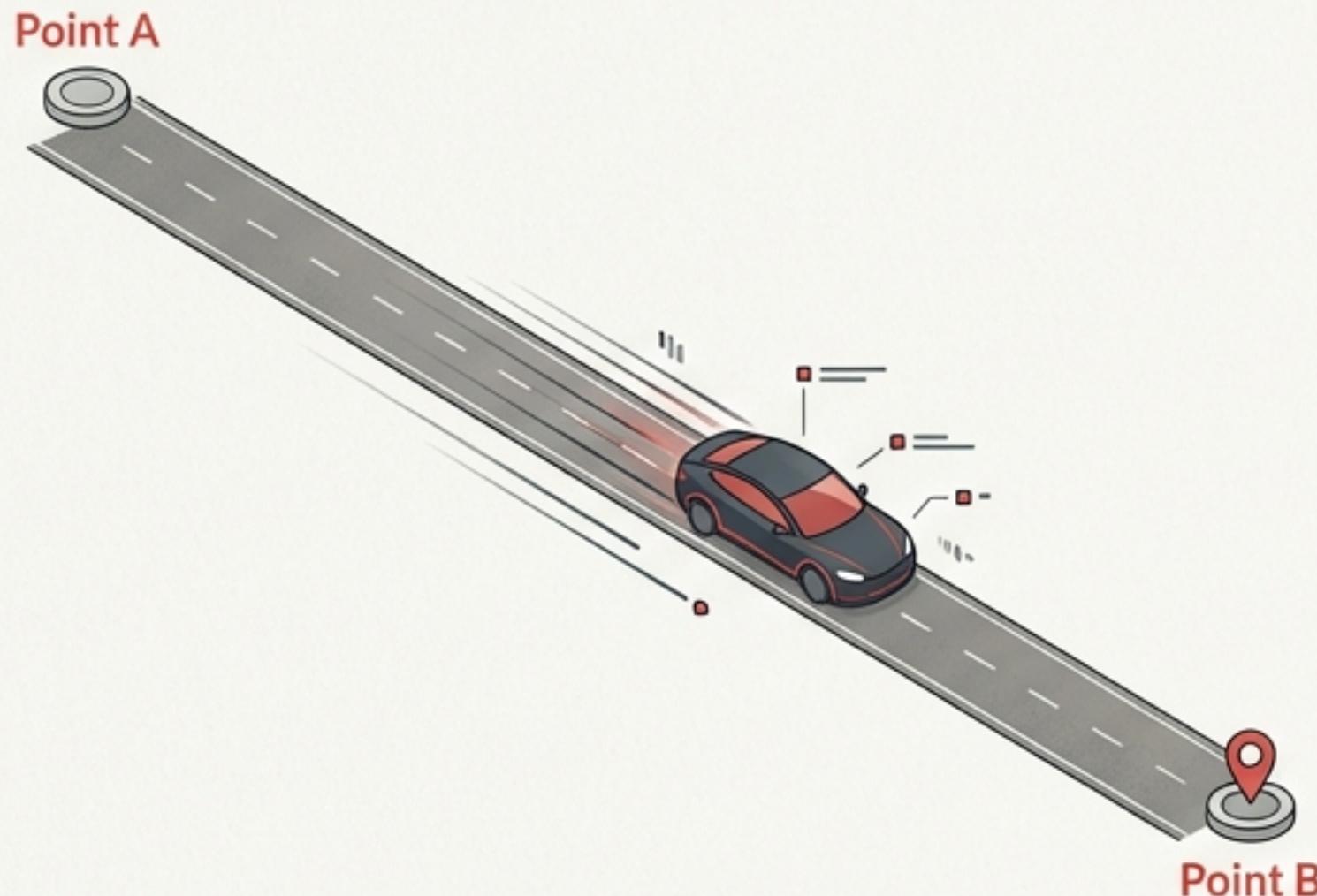
From Ionic Sparks to Conscious Perception



Perception is not a direct telegraph from the eye to the mind.  
It is a complex journey of interaction and integration.

# Why the Brain Takes the Long Way Home

Car A: The Expressway (Reflex)



Fast, Direct, informational.

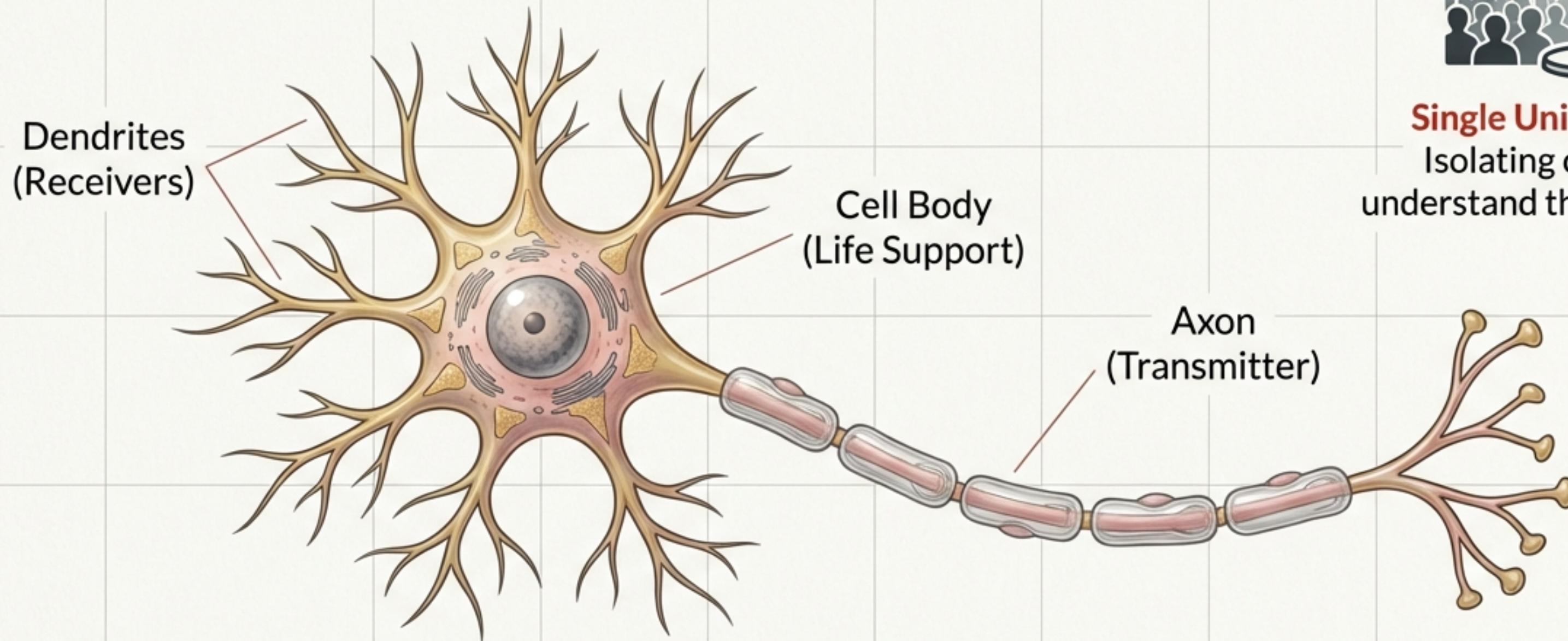
Car B: The Scenic Route (Perception)



Interactive, Complex, Experiential.

Direct transmission sends a signal. The 'scenic route' creates a perception. Neural processing is the interaction of signals that creates richness—lines, faces, movement—rather than just data points.

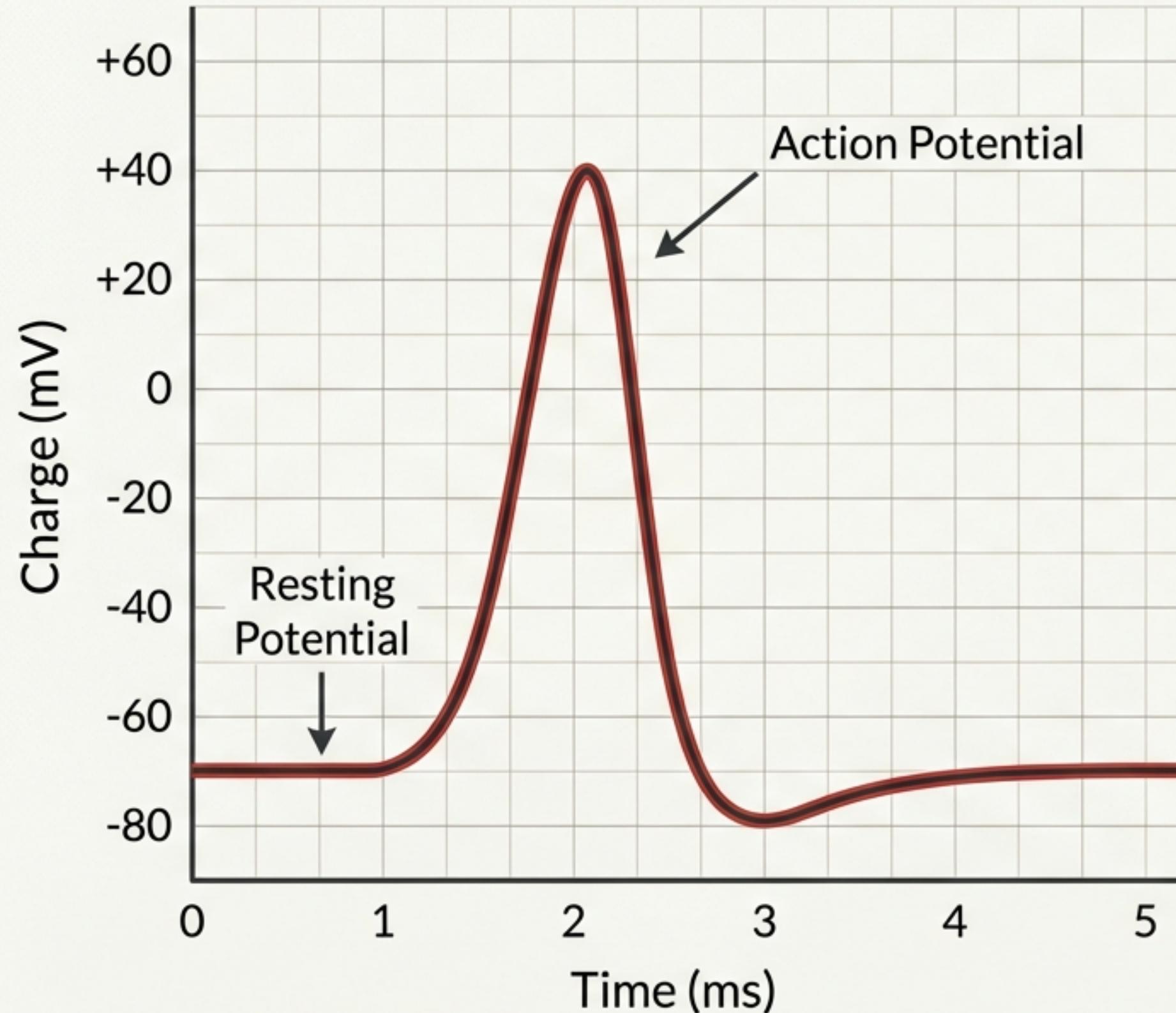
# The Microphone in the Crowd



**Single Unit Recording:**  
Isolating one voice to  
understand the conversation.

To understand neural activity, we use **microelectrodes** to measure the difference in charge between the inside and outside of a single neuron.

# The Currency of Experience: The Action Potential



## Key Properties

1. **The Propagated Response:** The signal travels the full length of the axon without fading.
2. **All-or-Nothing:** Intensity is not size, but rate.

Gentle Touch

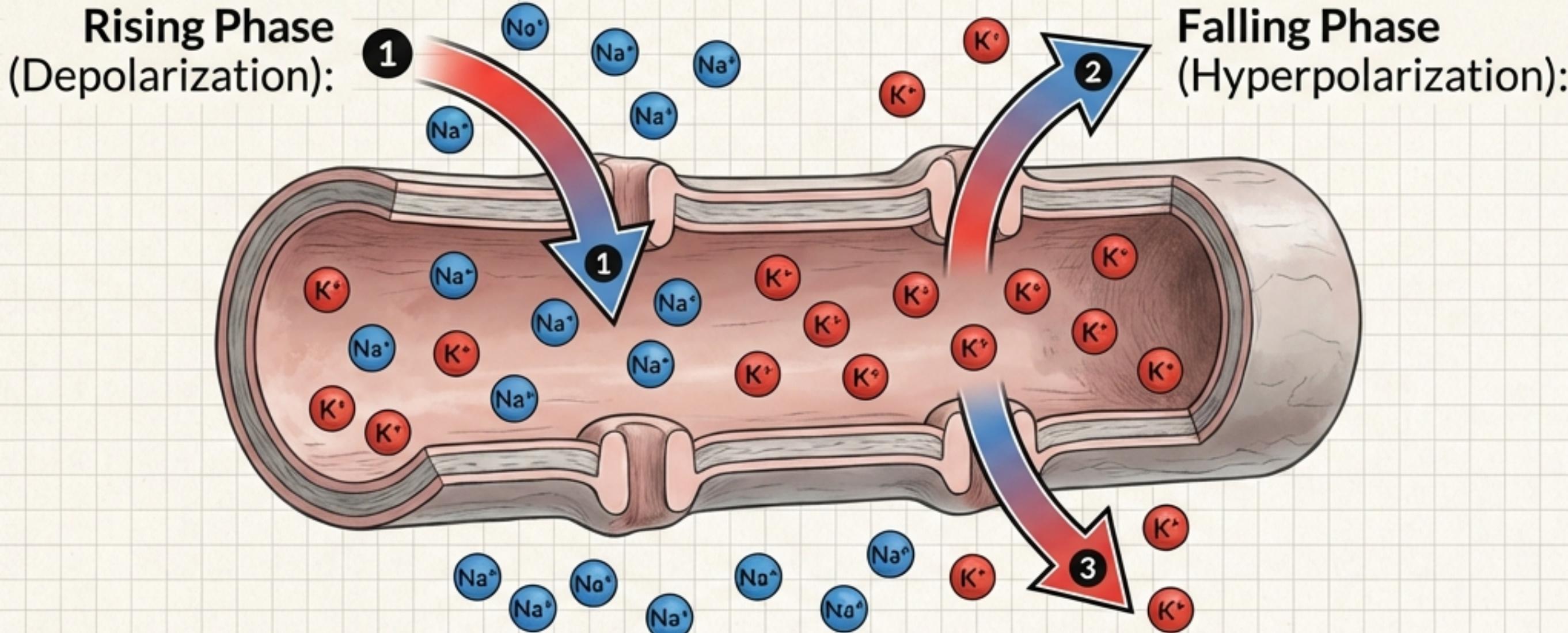


Hard Pressure



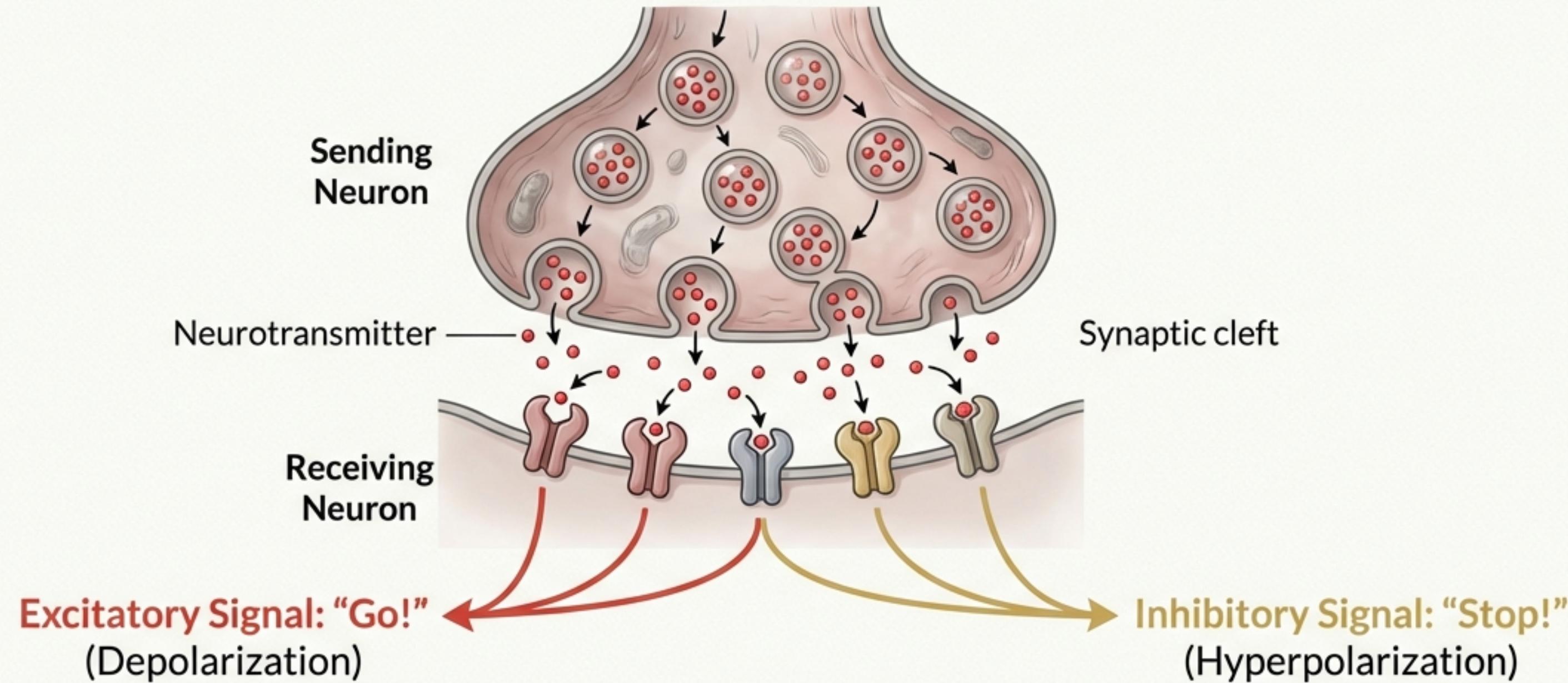
**Stronger stimulus = More frequent firing,**  
not bigger sparks. Limited by the **Refractory Period** (max 500-800 impulses/sec).

# Running on Wet Electricity



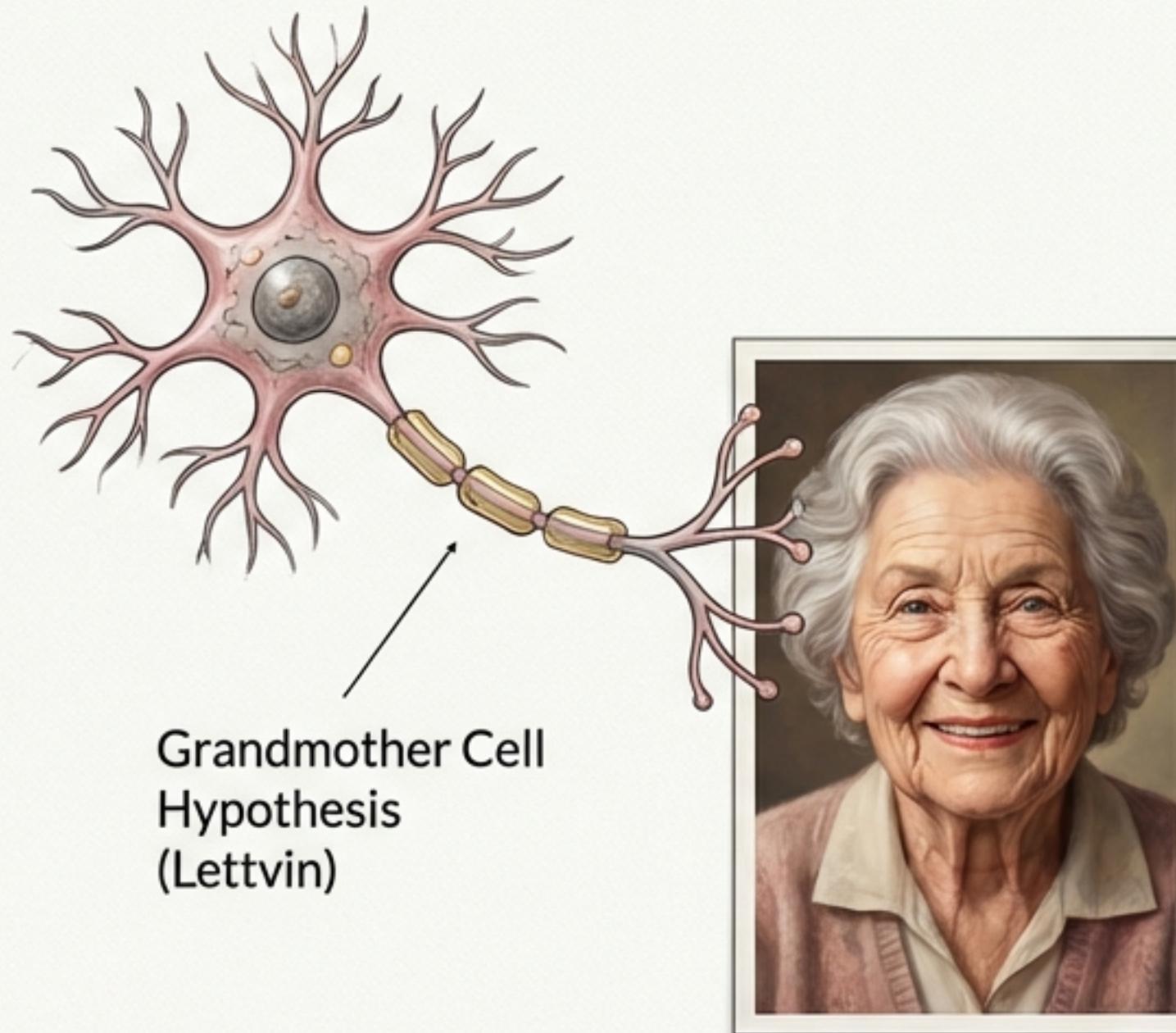
The **Sodium-Potassium pump** continuously resets this balance, maintaining the **battery** of the cell.

# Crossing the Synaptic Gap



This interplay of Go and Stop signals allows the brain to process information, not just transmit it.

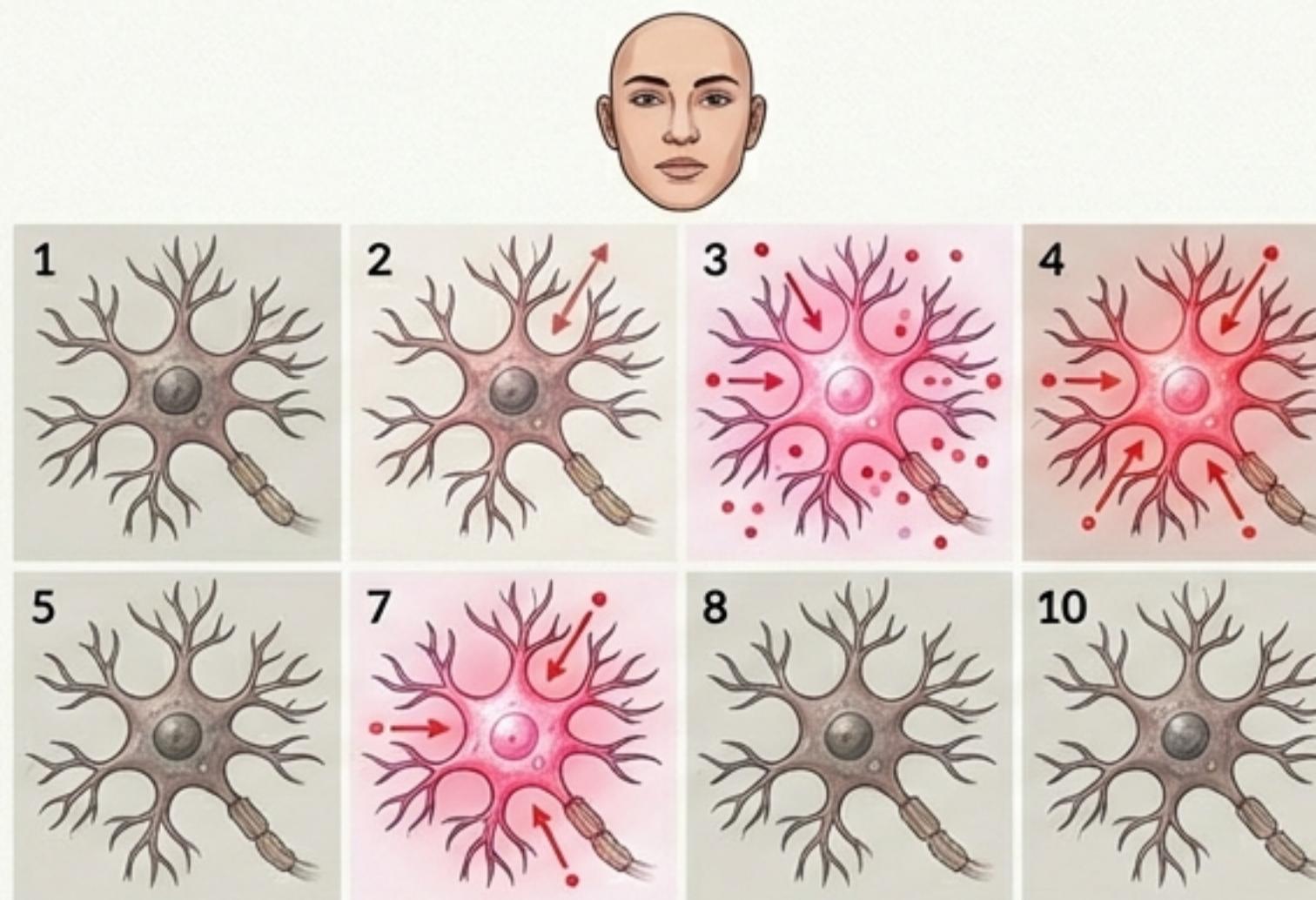
# Sensory Coding I: The Myth of the “Grandmother Cell”



**Evidence:** Quiroga et al. found neurons that fire specifically for concepts (like Steve Carell). However, **specificity coding** is likely too inefficient to be the whole story. If that neuron dies, do you forget **Steve Carell**?

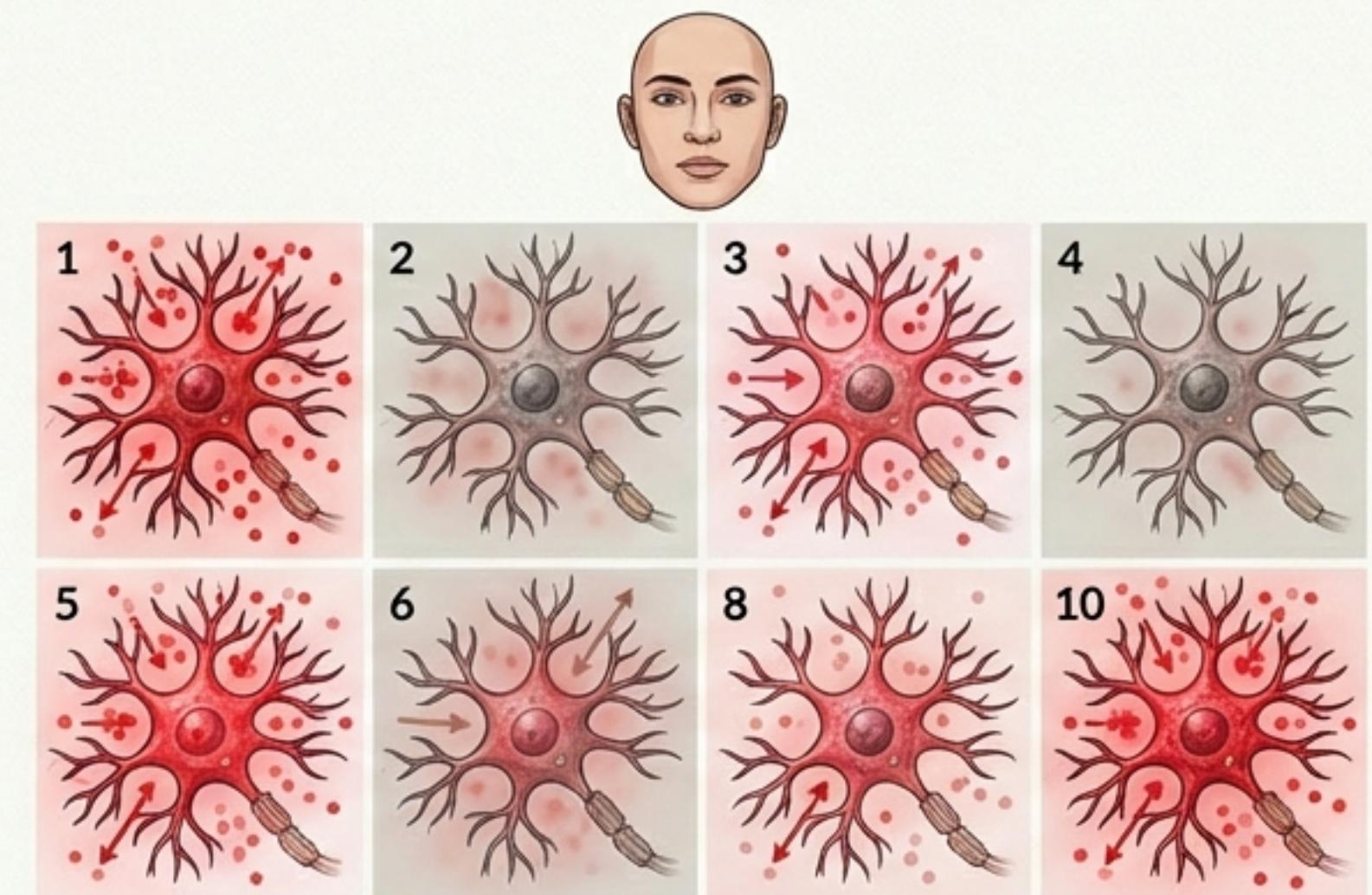
# Sensory Coding II: The Neural Choir

## Sparse Coding



Small groups firing. Efficient. Like a chamber ensemble.

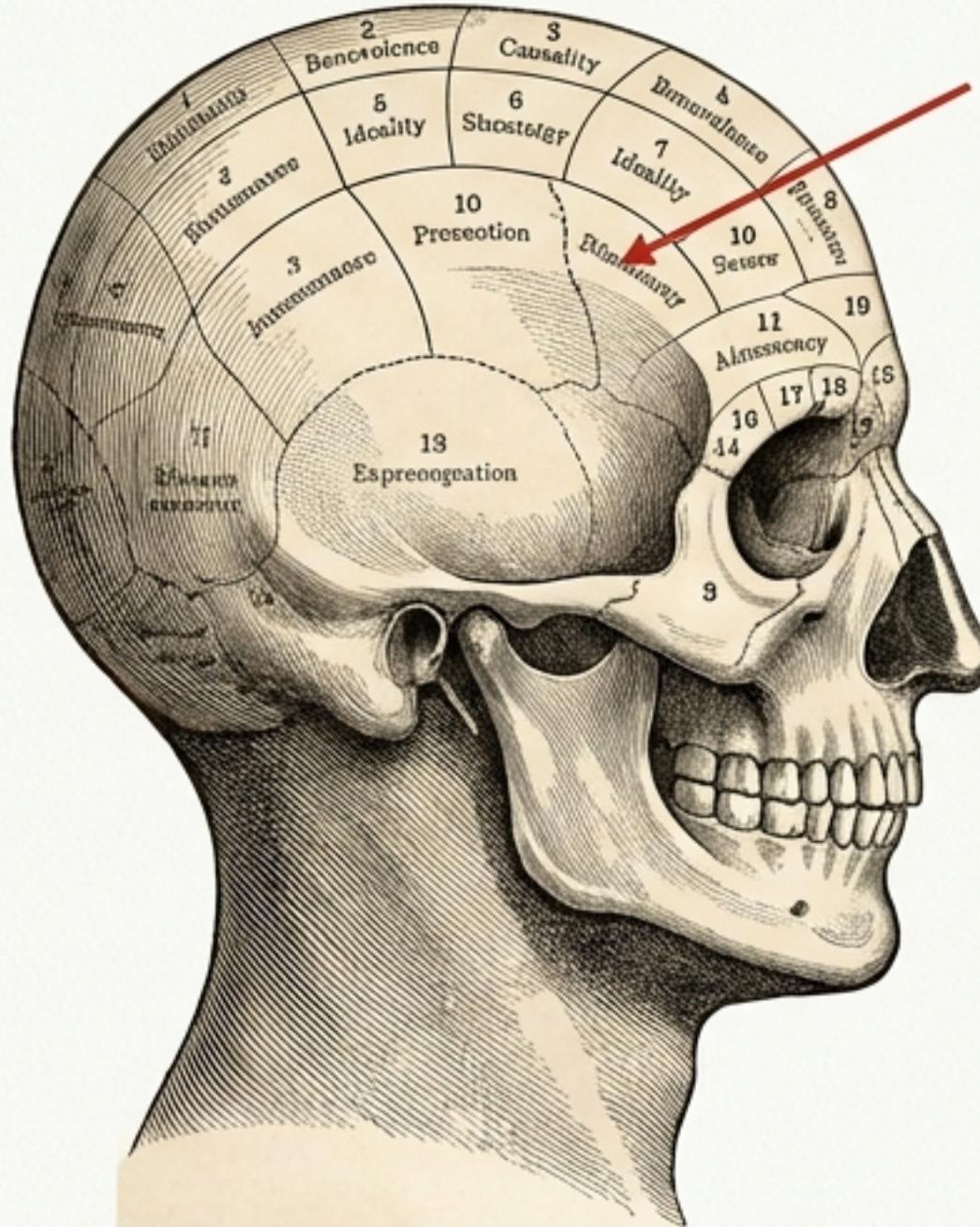
## Population Coding



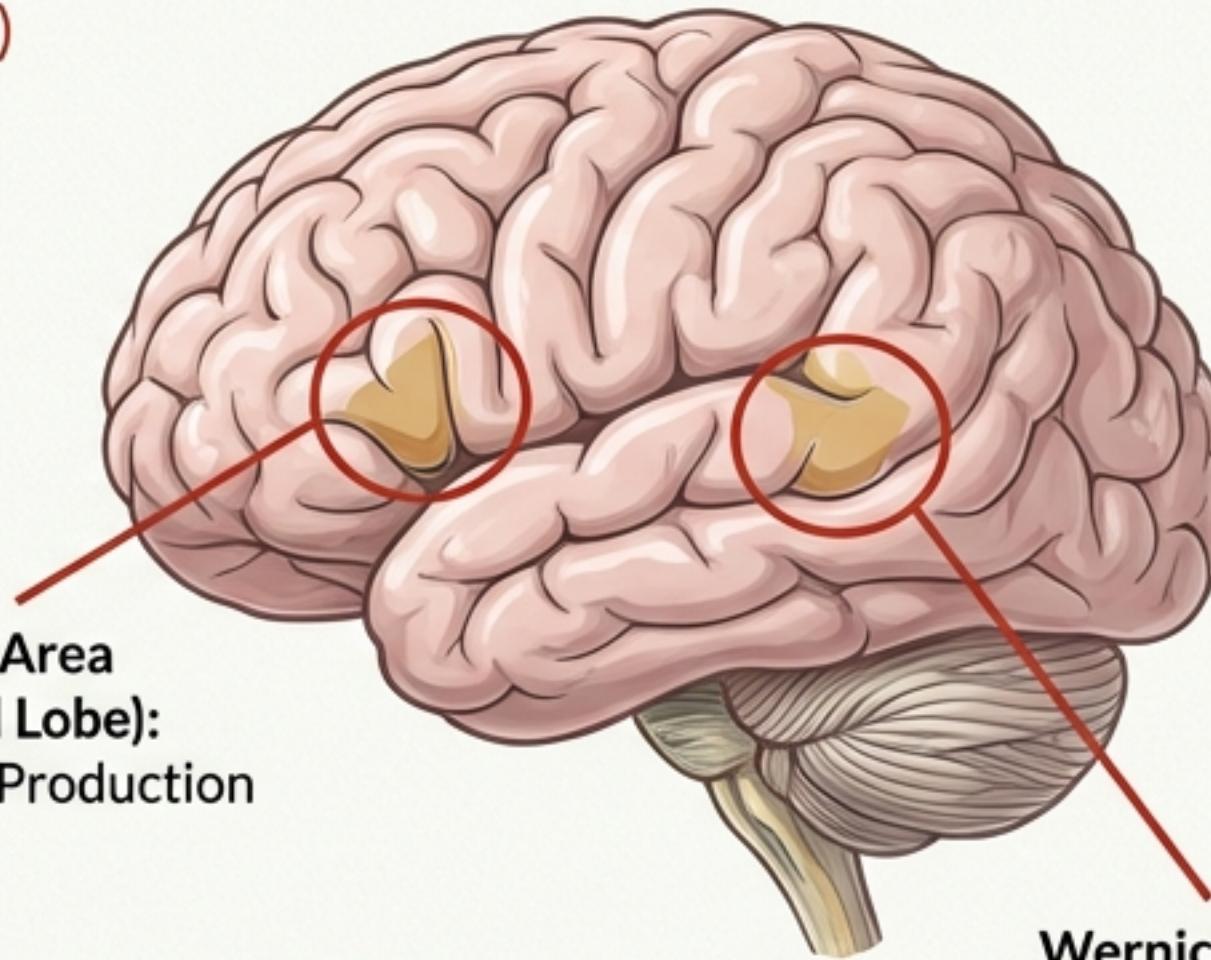
Large patterns firing. Robust. Like a symphony orchestra.

Most sensory representation is a **distributed choral effort, rarely a solo**.

# Mapping the Terrain: The History of Modularity



**Phrenology:** Right  
Intuition (Localization),  
Wrong Method (Skull Bumps)

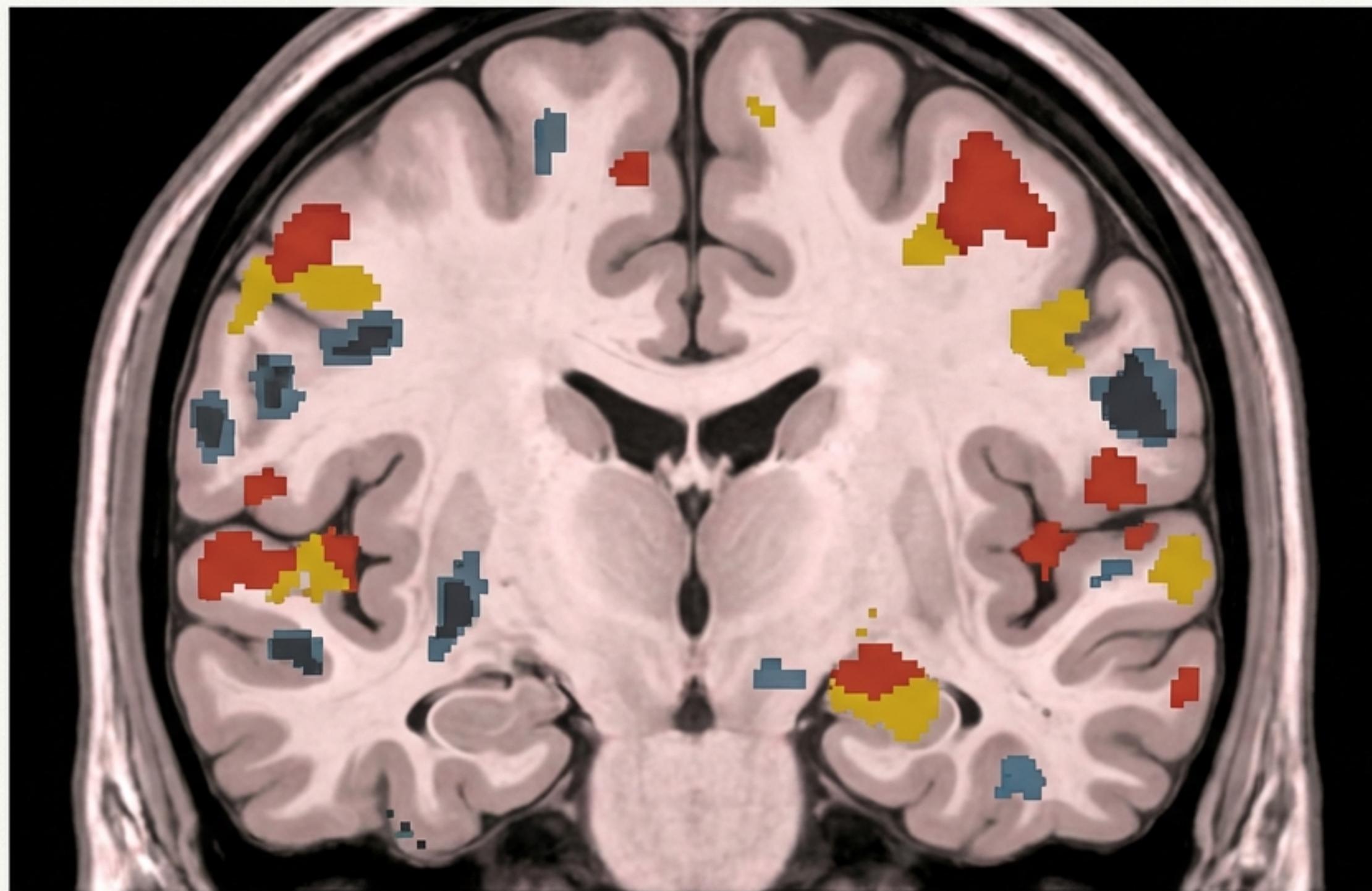


**Broca's Area  
(Frontal Lobe):**  
Speech Production

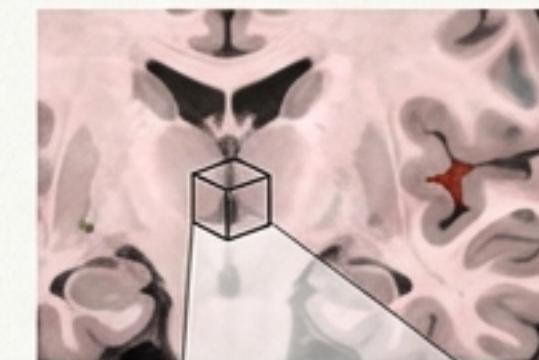
**Wernicke's Area  
(Temporal Lobe):**  
Speech Comprehension

**From pseudoscience to neuroscience:** Lesion studies (Patient 'Tan') confirmed that specific brain areas are indeed specialized for specific functions.

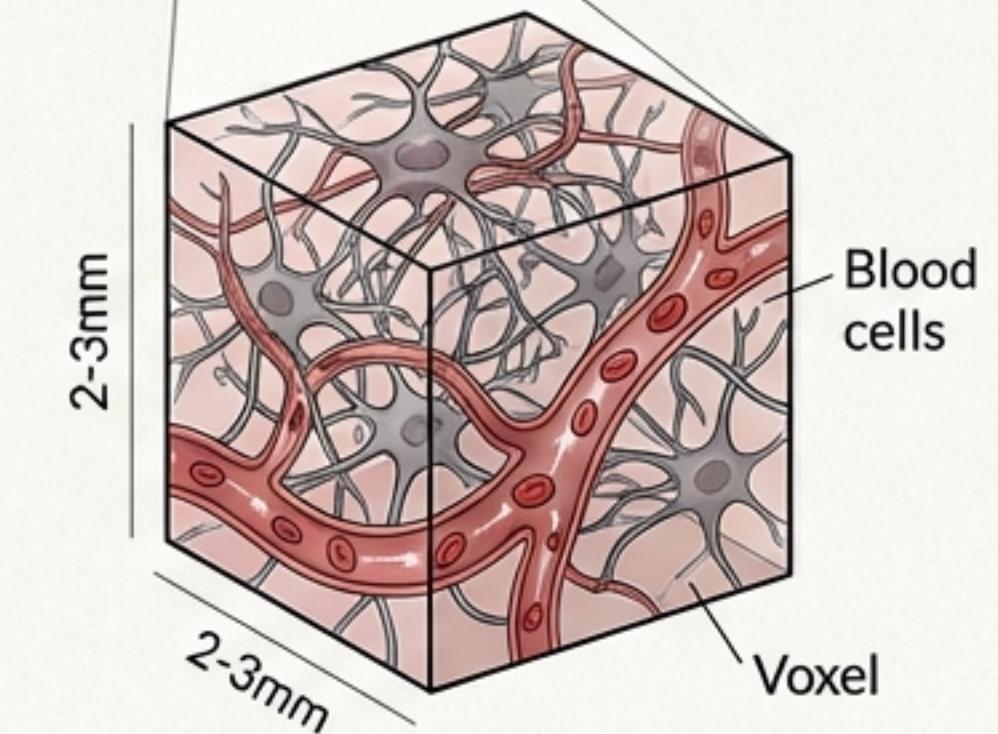
# Watching the Brain Think: fMRI



## The Voxel

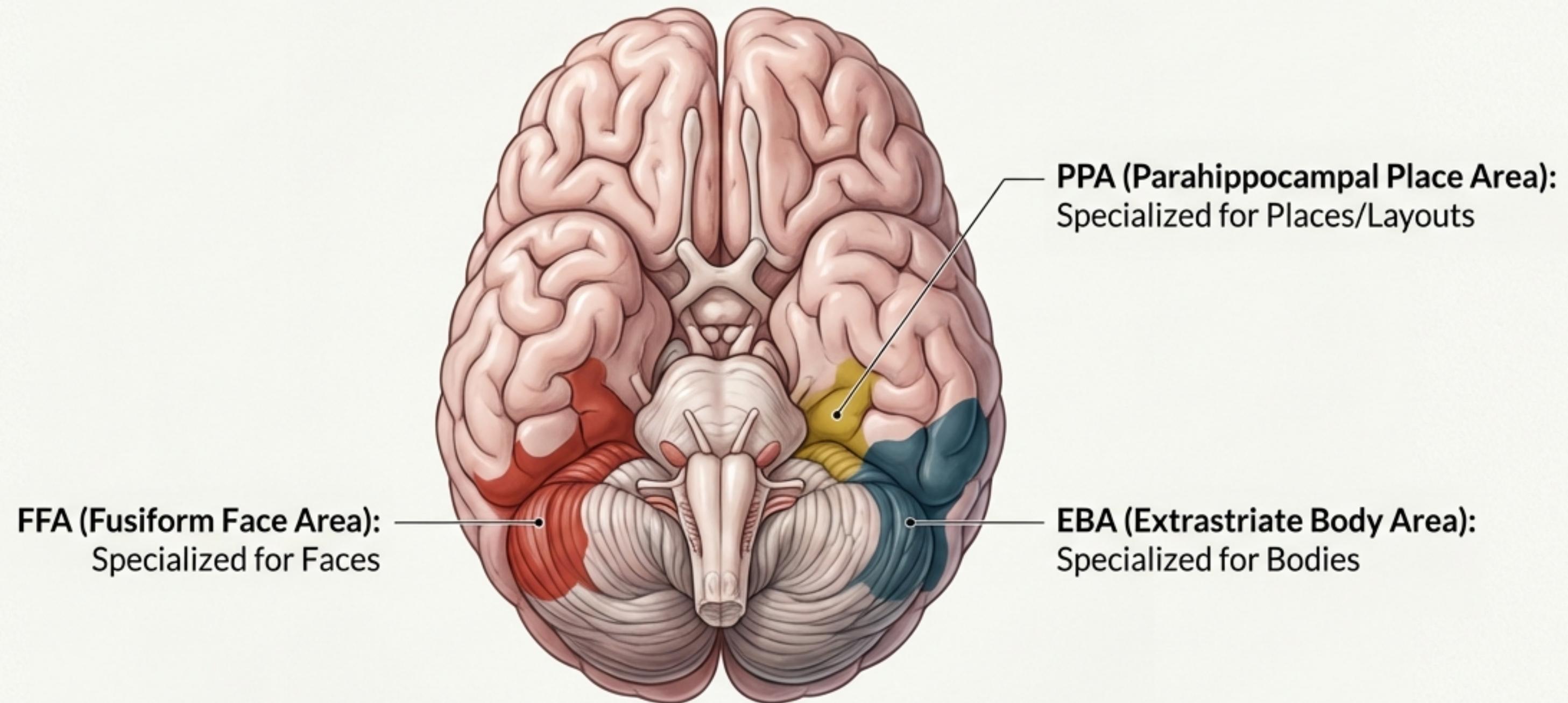


**Voxel:** A 3D pixel of brain tissue containing thousands of neurons.



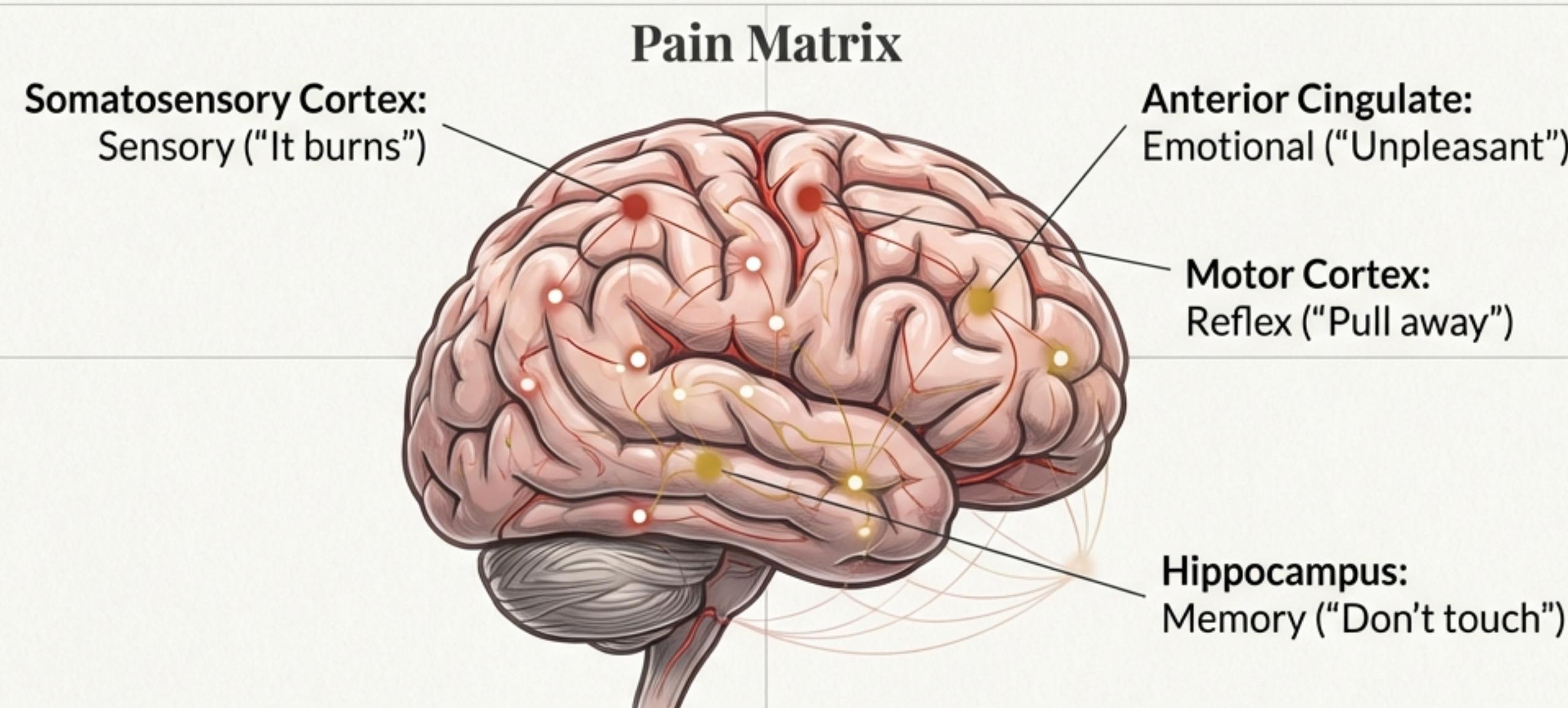
Functional MRI tracks blood flow (hemoglobin), not electricity. Active neurons demand more oxygen, making oxygenated blood a magnetic proxy for neural thought.

# The Brain's Specialized Departments



Modularity in action: Specific neighborhoods in the cortex are dedicated to processing specific categories of visual information.

# The Network Effect: Distributed Representation

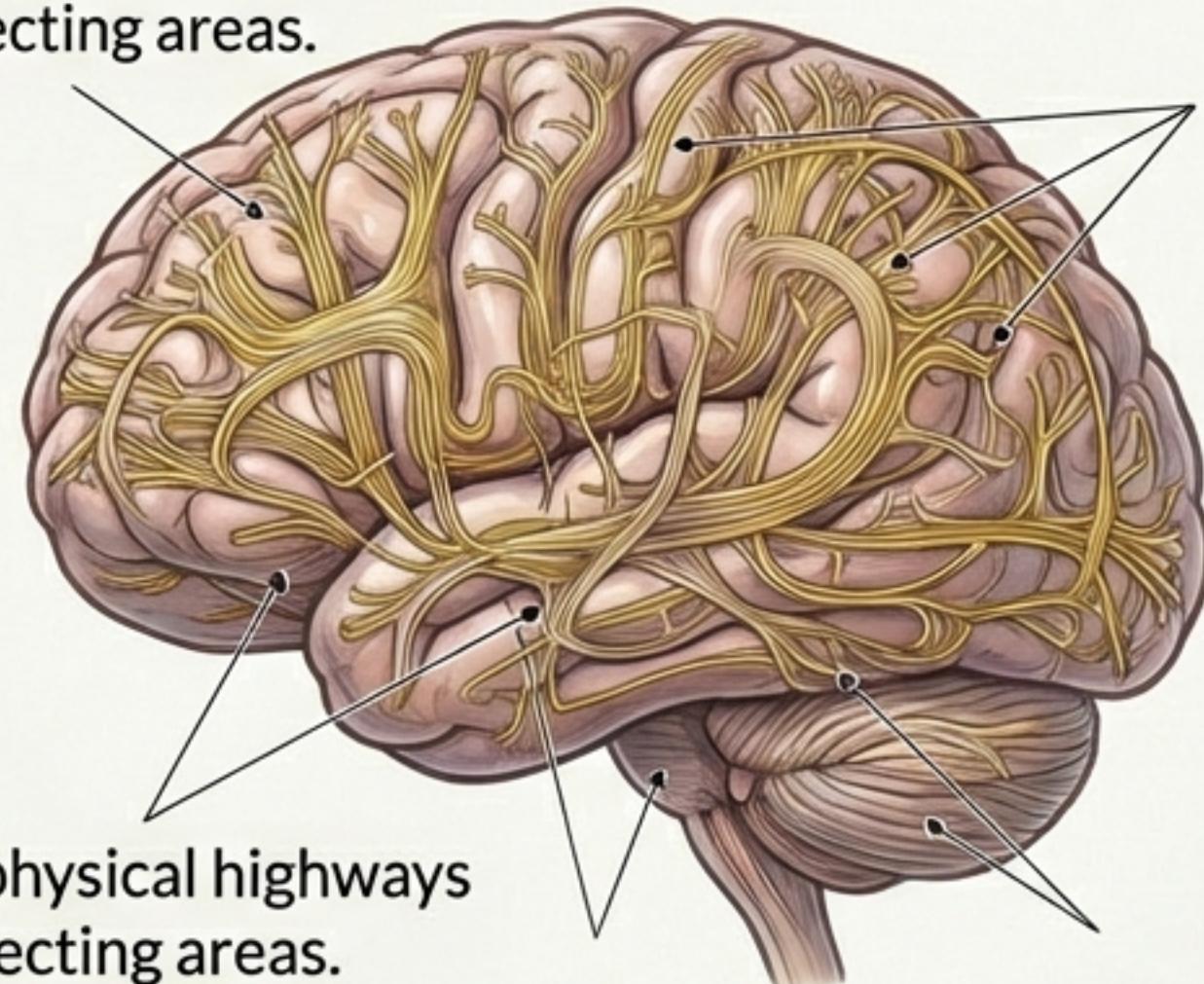


Perception is not just local; it is a symphony. A single experience like pain recruits a distributed network of modules working in unison.

# The Map vs. The Traffic

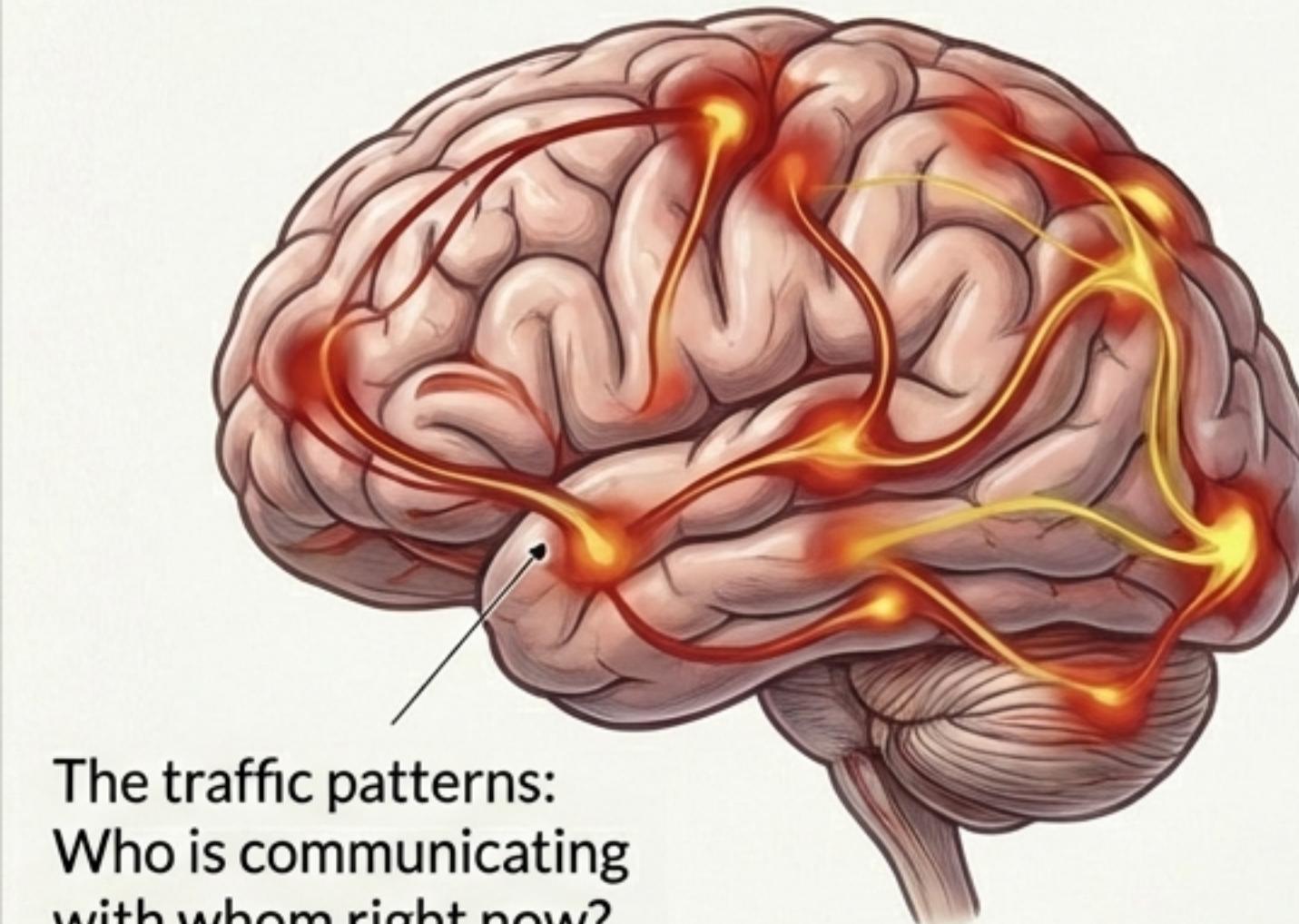
## Structural Connectivity (The Connectome)

The physical highways connecting areas.



The physical highways connecting areas.

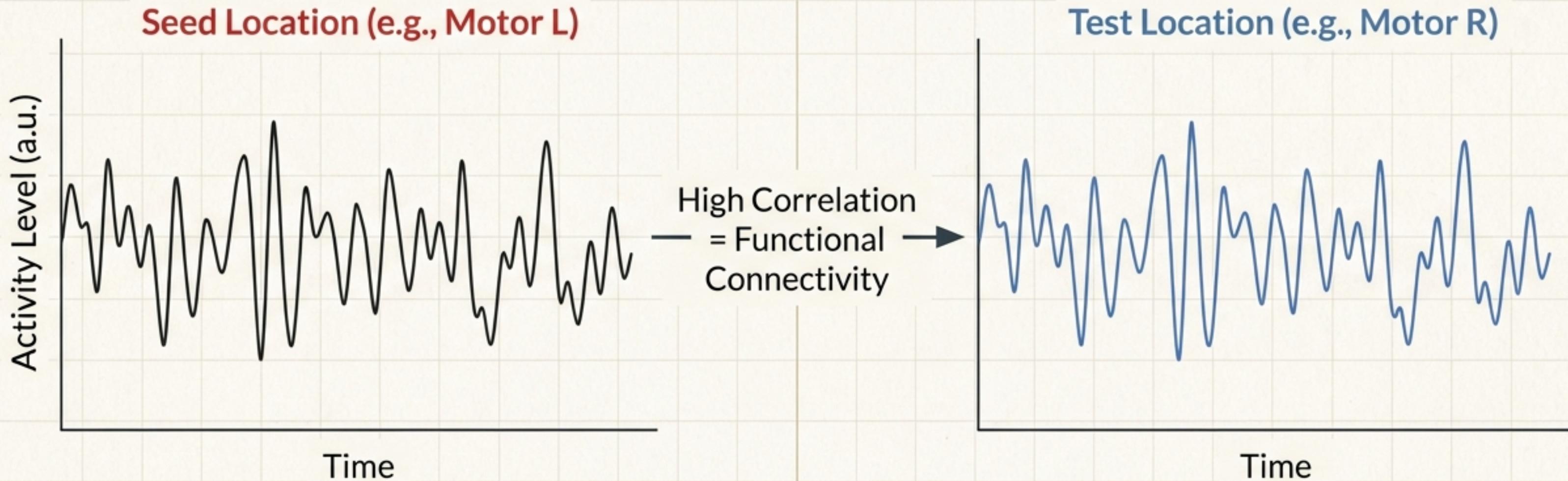
## Functional Connectivity



The traffic patterns:  
Who is communicating  
with whom right now?

Areas do not need to be physical neighbors to be functionally connected.  
They just need to be part of the same traffic flow.

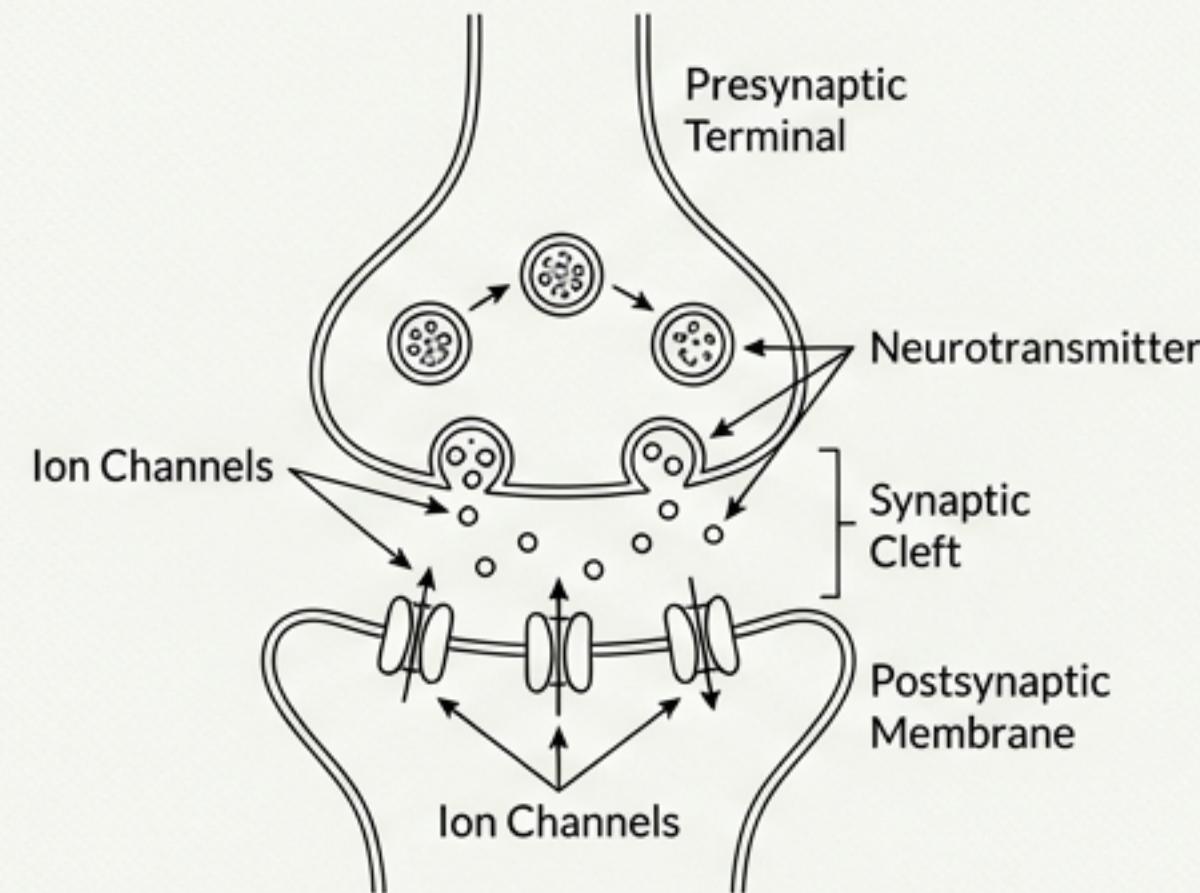
# The Brain Never Sleeps: Resting State



**The Default Mode Network:** Even when you are “doing nothing,” your brain maintains active, synchronized networks. This baseline activity predicts your ability to perceive the world.

# The Final Frontier: The Mind-Body Problem

## The Body



## Mechanism (Correlation)

## The Mind



## Experience (Causation?)

We can map the wires, but we cannot yet explain the ghost in the machine. Science gives us the **correlation** between **+40mV** and '**Red**', but not the **cause** of the feeling itself.

The Scenic Route continues...