

Round 2: The Somatosensory System

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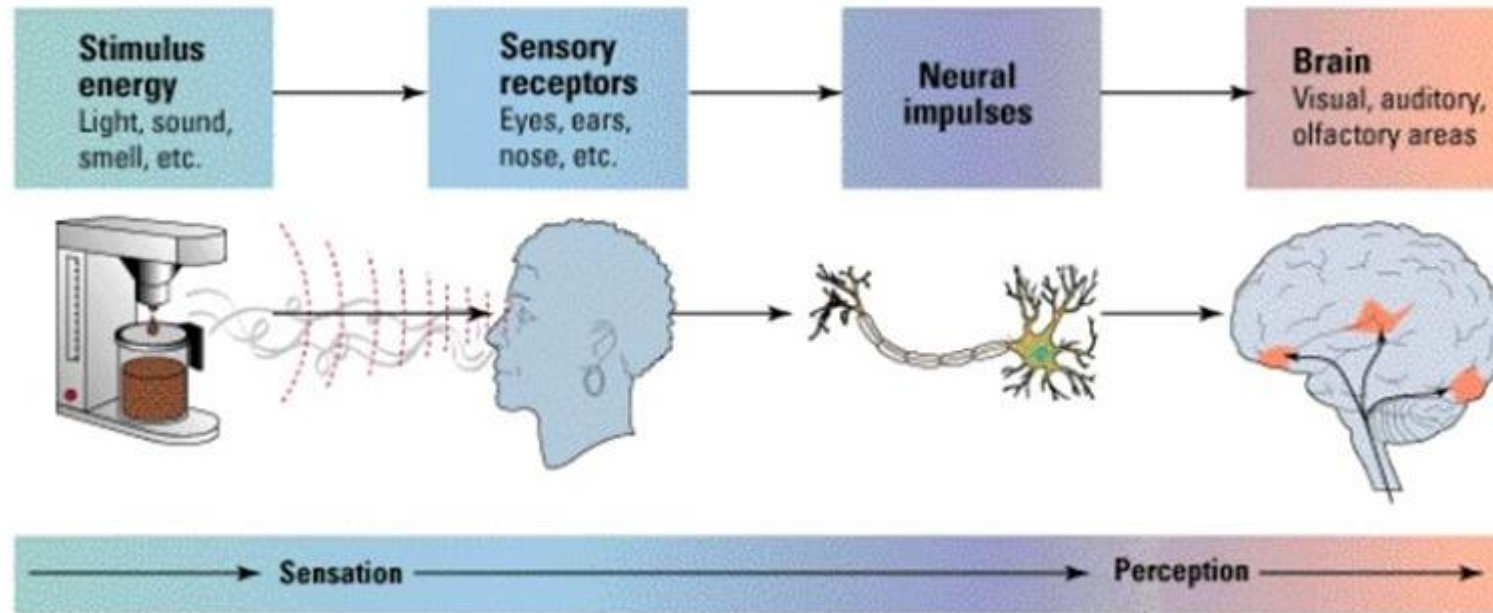
If a tree falls in the forest and there's no one around to hear it, does it make a sound?



No, when a tree hits the ground it creates vibrations. A brain is necessary to transform pressure waves into a sound.

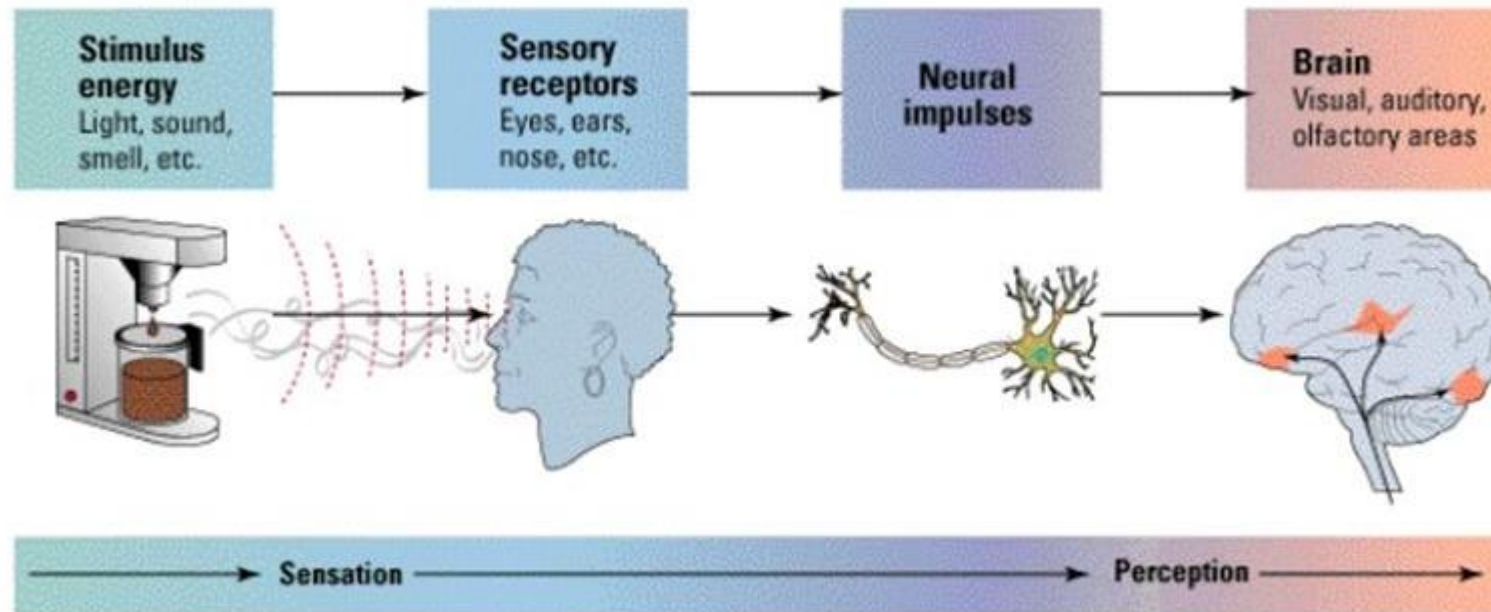
Colors, tones, smells, and tastes do not exist in the universe outside of a brain. They are mental constructs.

Sensation – Receiving information from the environment



Transduction – Stimulus is picked up by a receptor (e.g., mechanical, thermal, chemical, etc.) converted into electrochemical energy (i.e., action potentials) and relayed to the central nervous system by projection neurons.

Neuronal Encoding – series of action potentials



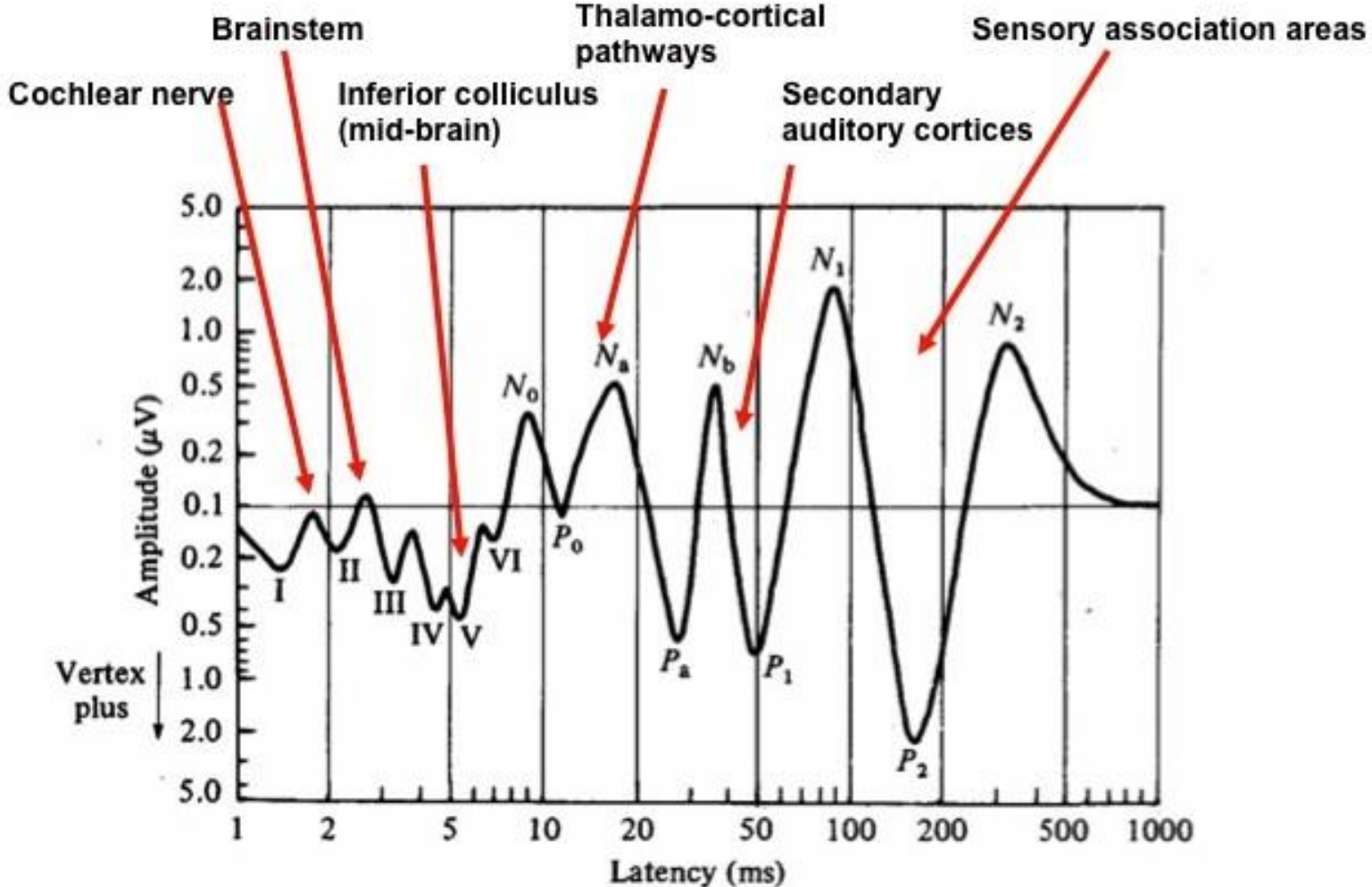
Information Attributes

- Modality (e.g., vision, hearing, touch, taste, smell)
- Intensity
- Duration
- Location

Information Communicated

- Within a single neuron by mean impulse activity or latency (i.e., interval between impulses)
- Group of neurons by number or distribution of neurons

Event-related Potential (ERP) – measured brain response as a direct result of sensory, cognitive, or motor event.



Auditory evoked potentials



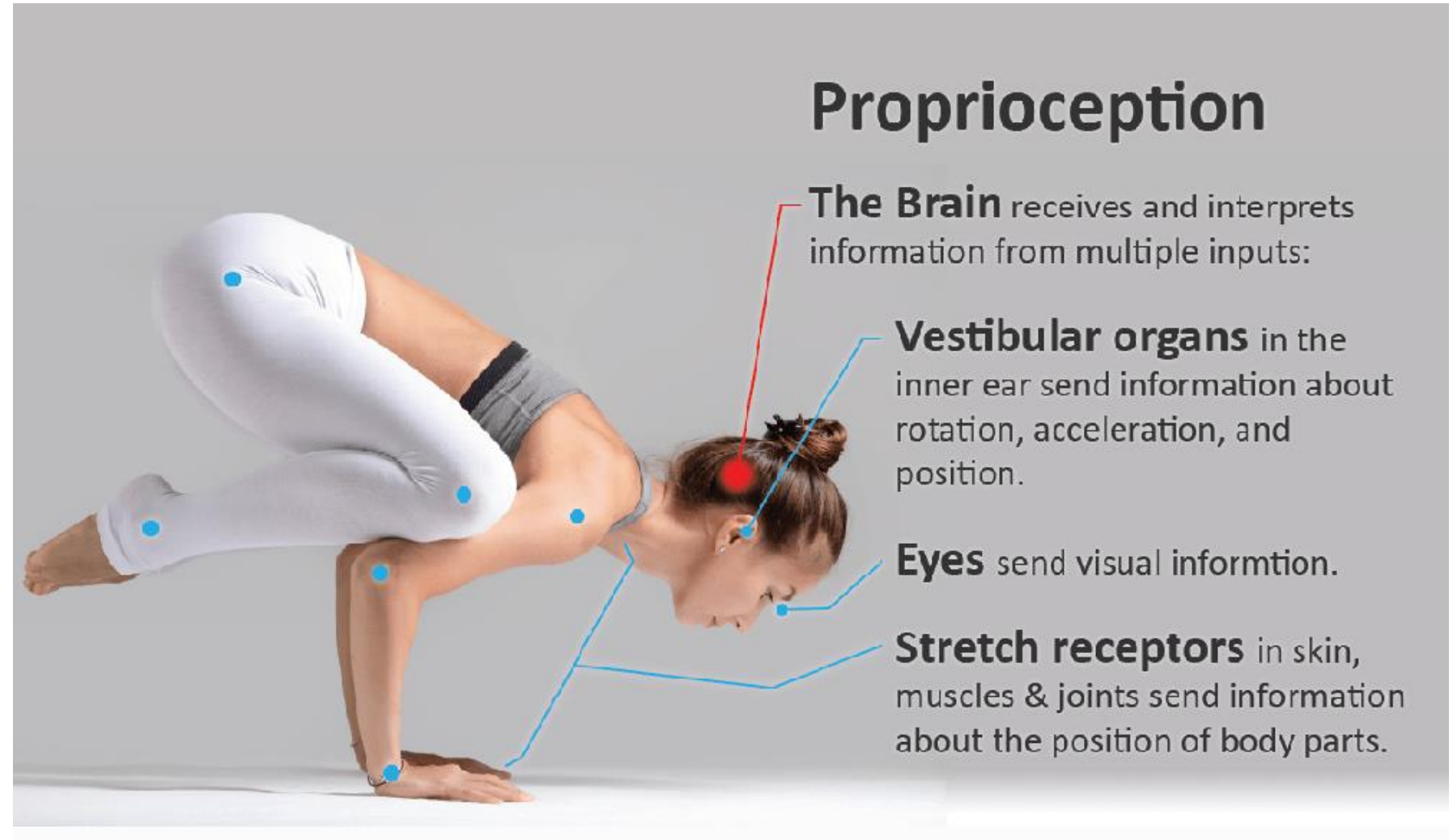
The
Somatosensory
System

The Somatosensory System

Four Somatosensory modalities:

1. Proprioception –

- Sense of body movement & position.
- Mechanical displacements of muscles and joints.



The Somatosensory System

Four Somatosensory modalities:

2. Thermal/Temperature –

- Heat respond to 32-45°C (90-113°F)
- Cold respond to 1-20°C below normal skin temp of 34°C (93°F)



The Somatosensory System

Four Somatosensory modalities:

3. Pain – Tissue damaging stimuli

- Nociceptors (Latin Nocere – “to injure”)
- Mechanical – sharp objects
- Thermal – above 45°C (113°F)
- Polymodal – mechanical, heat, chemical



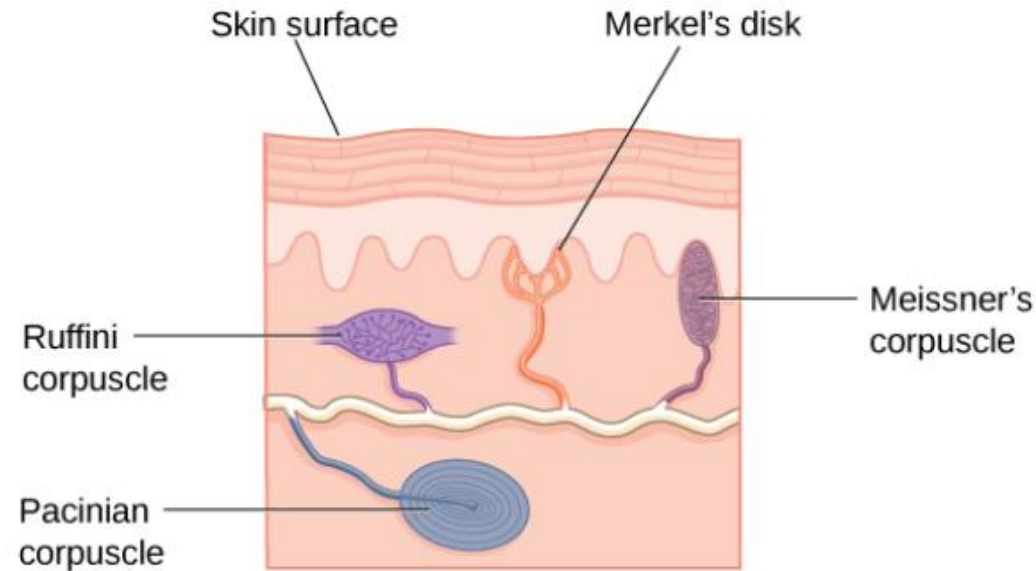
The Somatosensory System

Four Somatosensory modalities:

4. Touch –

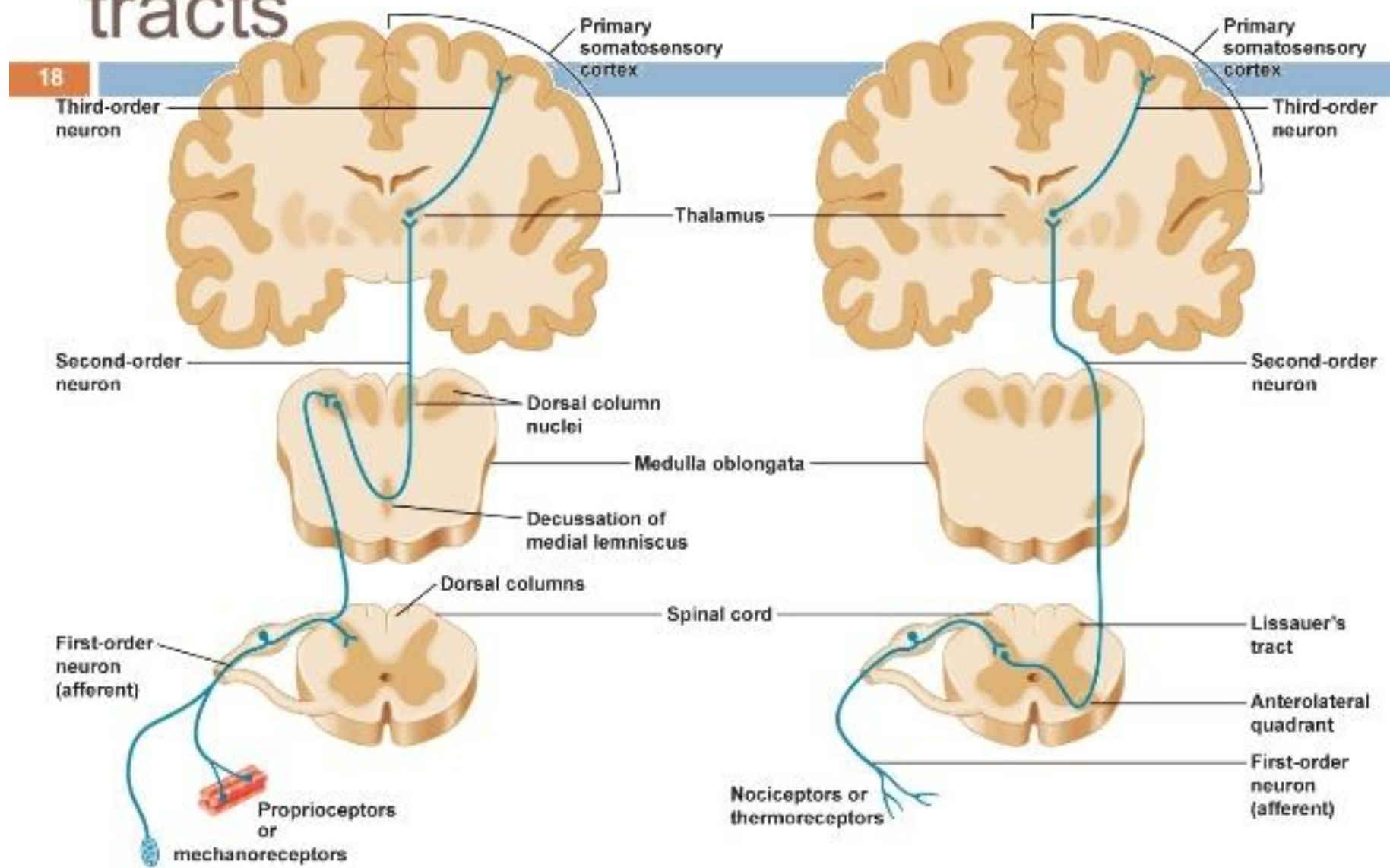
- Mechanical stimulation of body surface





	Placement	Resolution	Type	Function
Merkel Receptor	Superficial	Fine	Slow	Pressure, Position, Shape, Edges
Meissner Corpuscle	Superficial	Fine	Rapid	Indentation, Most Sensitive – Light Touch
Ruffini Corpuscle	Deep	Coarse	Slow	Skin Stretching, Movement, Finger Position, Object Slippage
Pacinian Corpuscle	Deep	Coarse	Rapid	Timing, Vibration, Texture

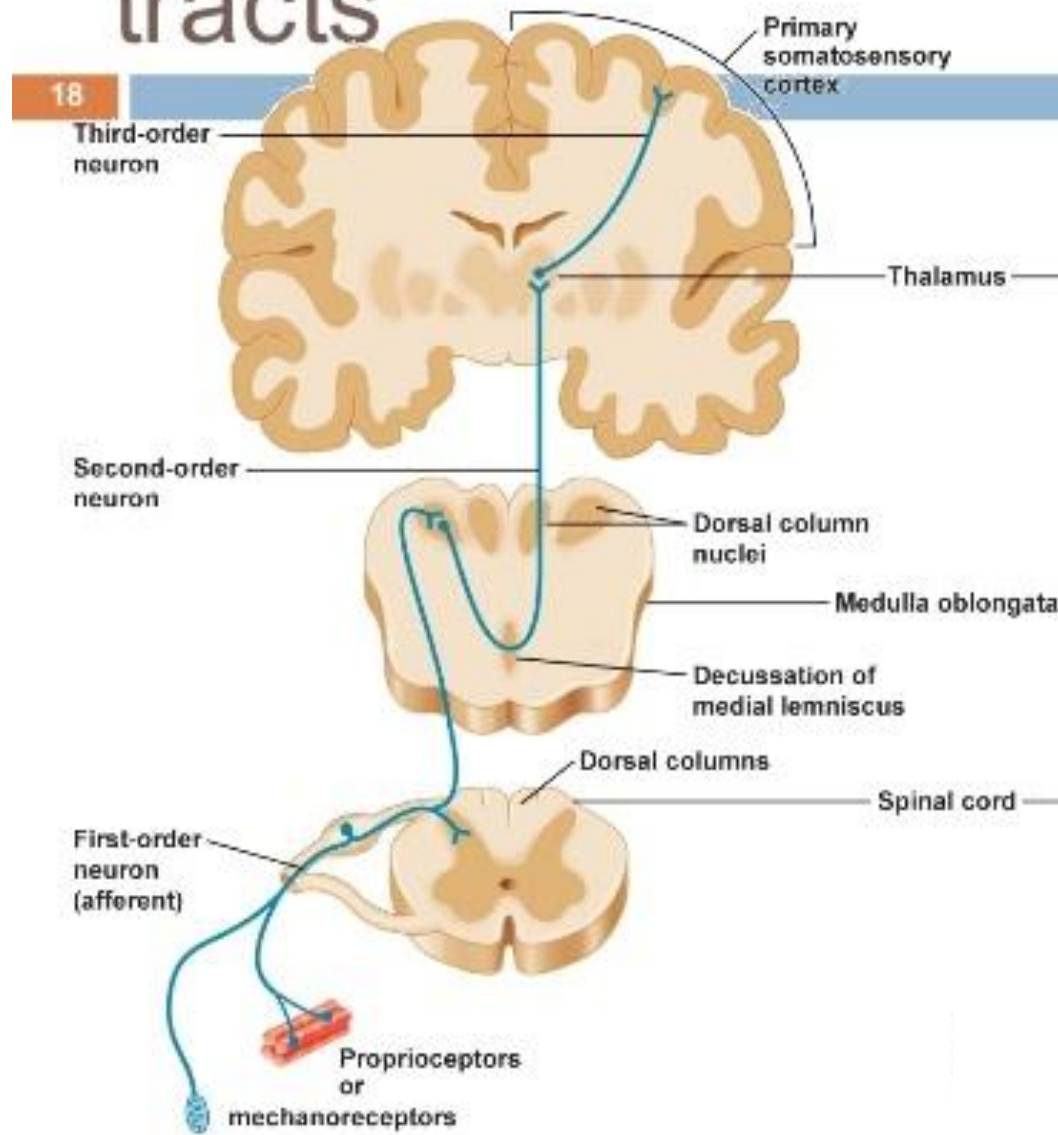
Somatosensory projections: tracts



1. Dorsal column-medial lemniscus pathway

2. Anterolateral pathway

Somatosensory projections: tracts



1. Dorsal column-medial lemniscus pathway

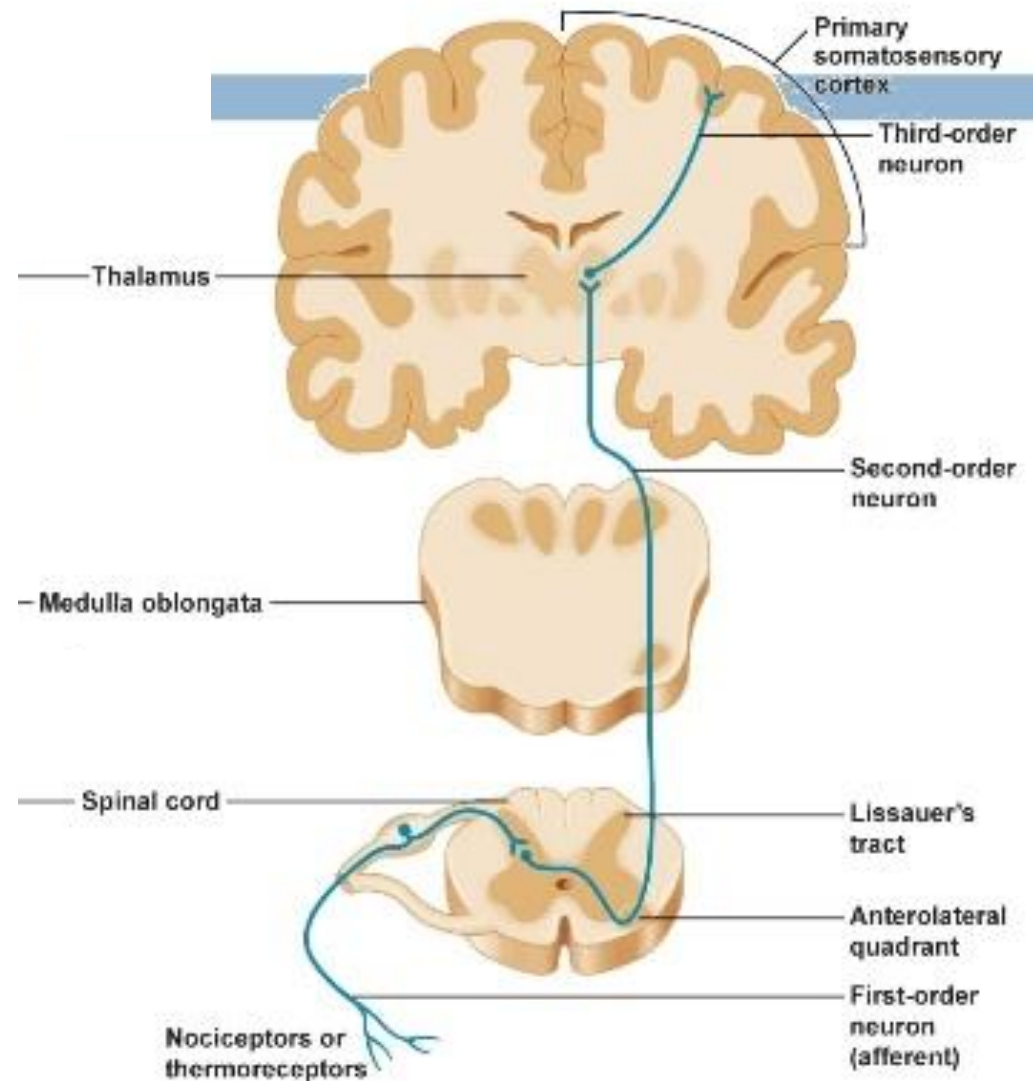
Dorsal Column-Medial Lemniscus Pathway

- Relays information about tactile sensation including touch, vibration, and limb proprioception
- Series of relay nuclei
 1. Peripheral axons
 2. Dorsal root ganglion
 3. Dorsal column
 4. Second-order neurons in dorsal column
 5. Cross midline in Medulla
 6. Brain Stem
 7. Thalamus – synapse onto third-order cells in ventral posterior medial & Lateral nuclei
 8. Primary somatosensory cortex in postcentral gyrus of parietal lobe

Somatosensory projections:

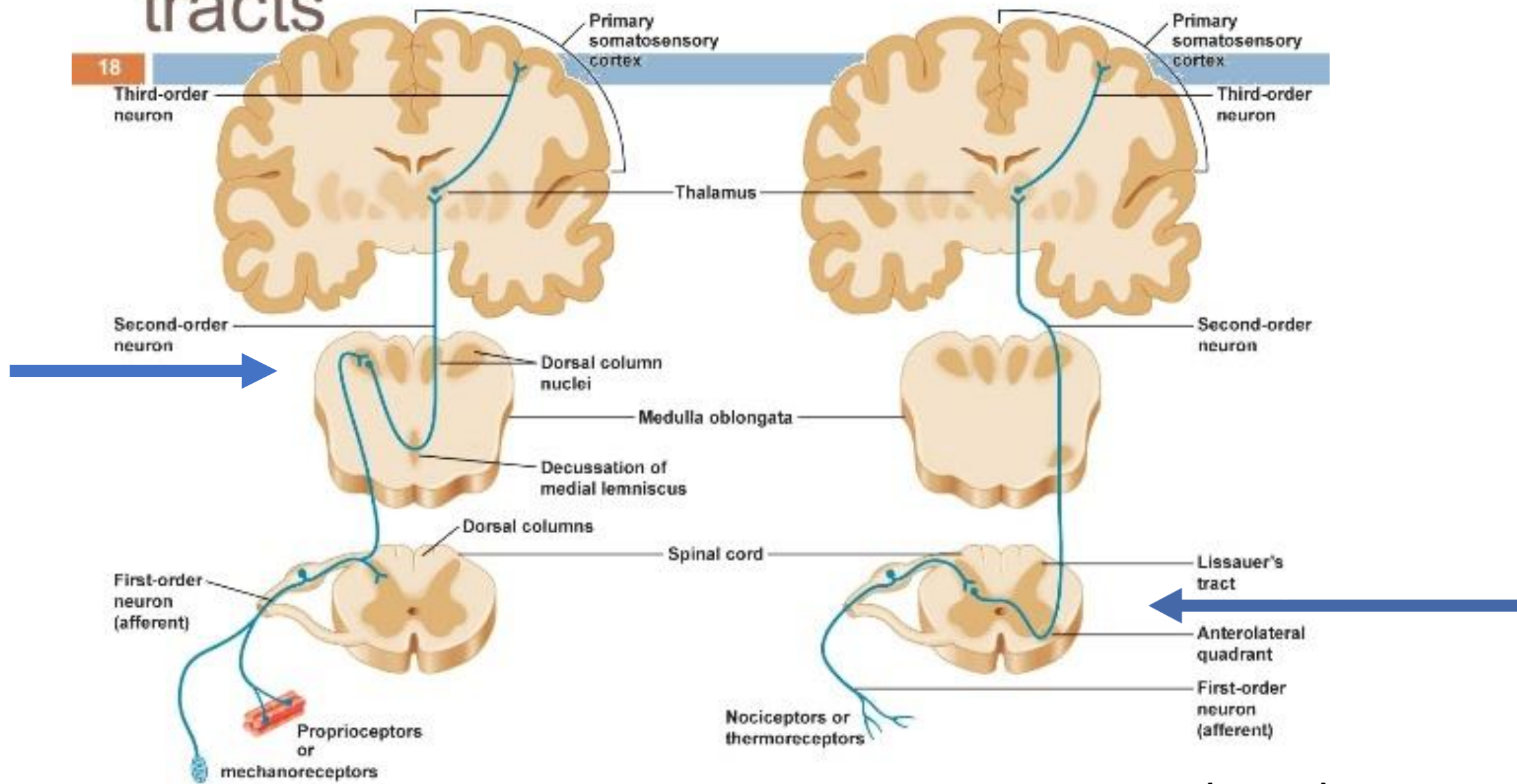
Anterolateral Pathway

- Relays information about pain and temperature
- Dorsal horn of spinal cord -> reticular formation of pons & medulla -> thalamus
 - Reticular Formation – Arousal
 - Pons & Medulla – Autonomic system that regulates involuntary functions (e.g., blood pressures, respiration)



2. Anterolateral pathway

Somatosensory projections: tracts

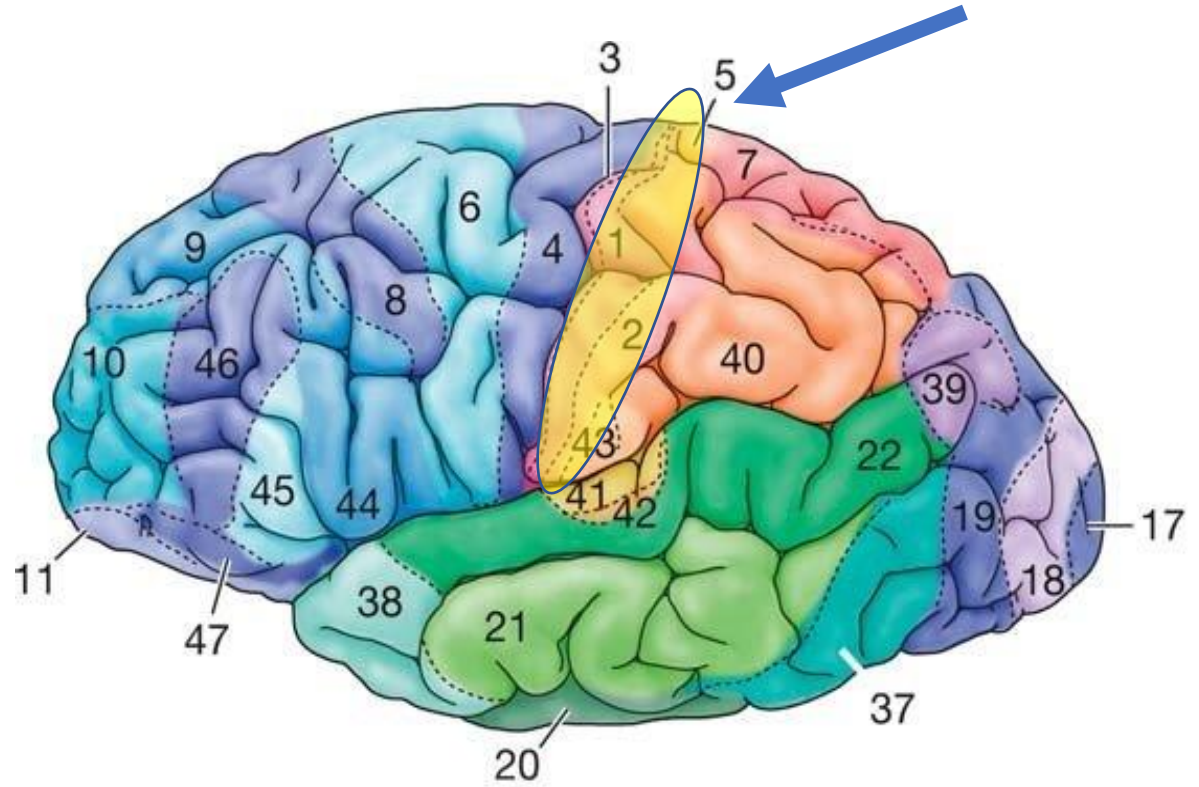
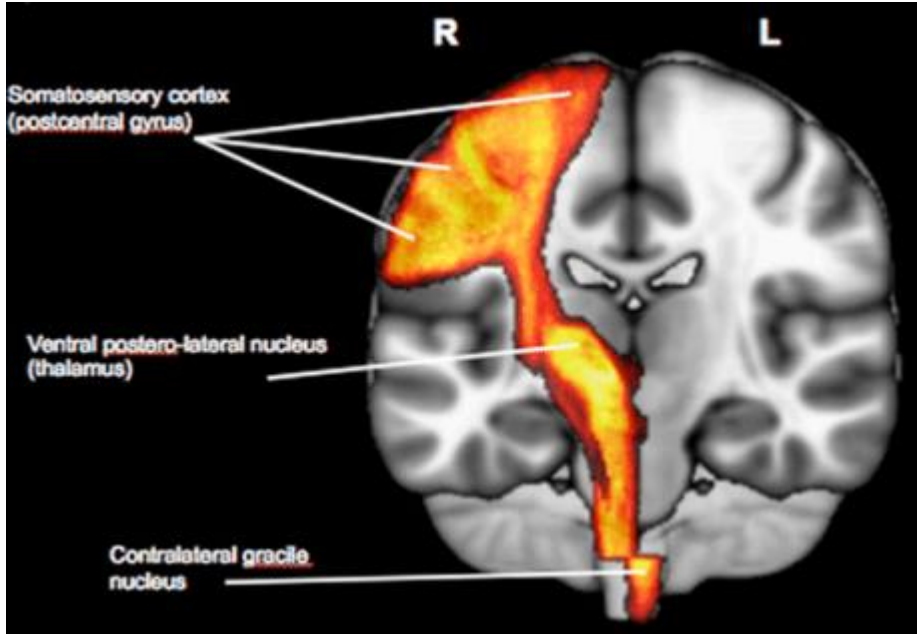


(Tactile)

1. Dorsal column-medial lemniscus pathway

2. Anterolateral pathway

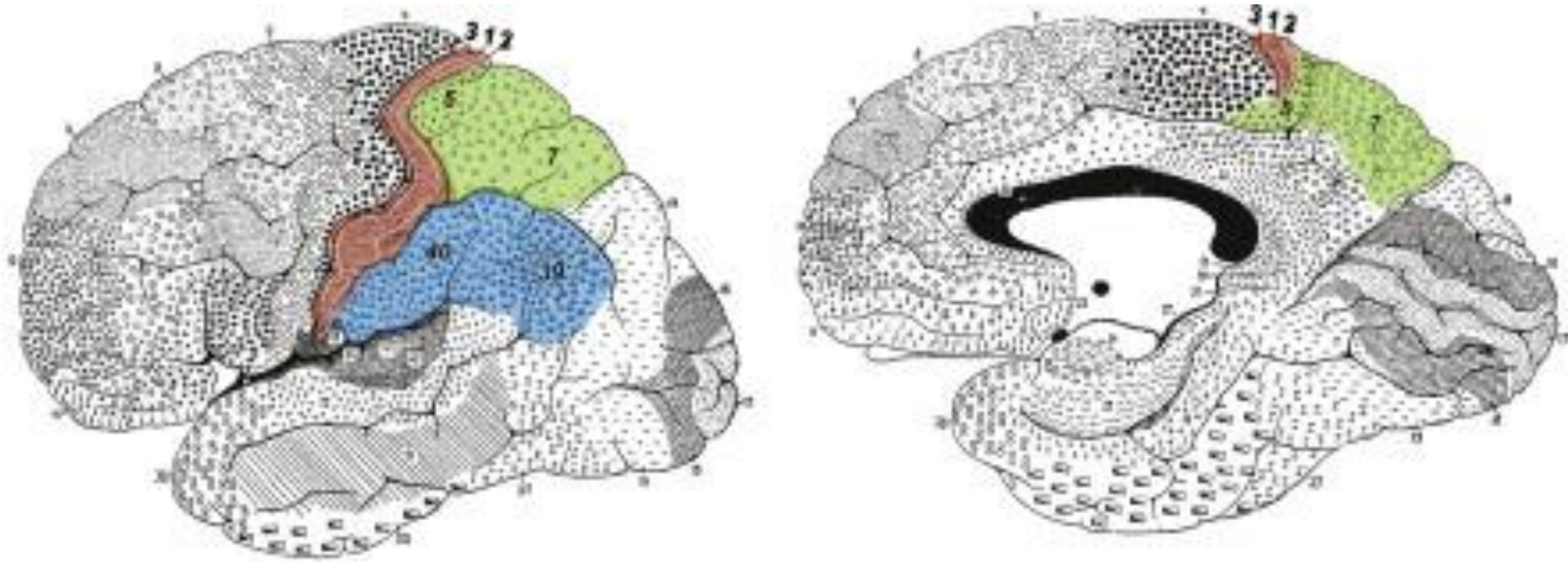
(Pain)

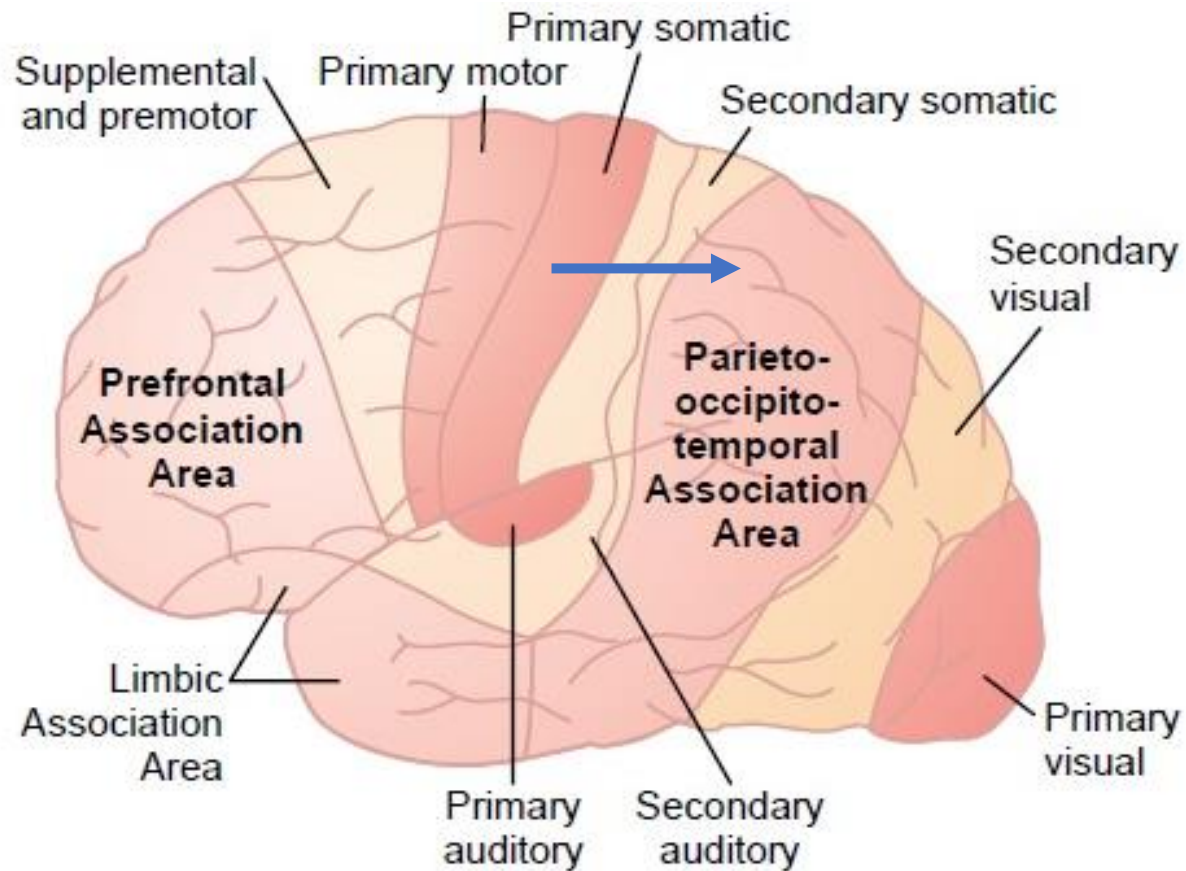


Sulcus – valley
Gyrus - hill

Brodmann's Areas –

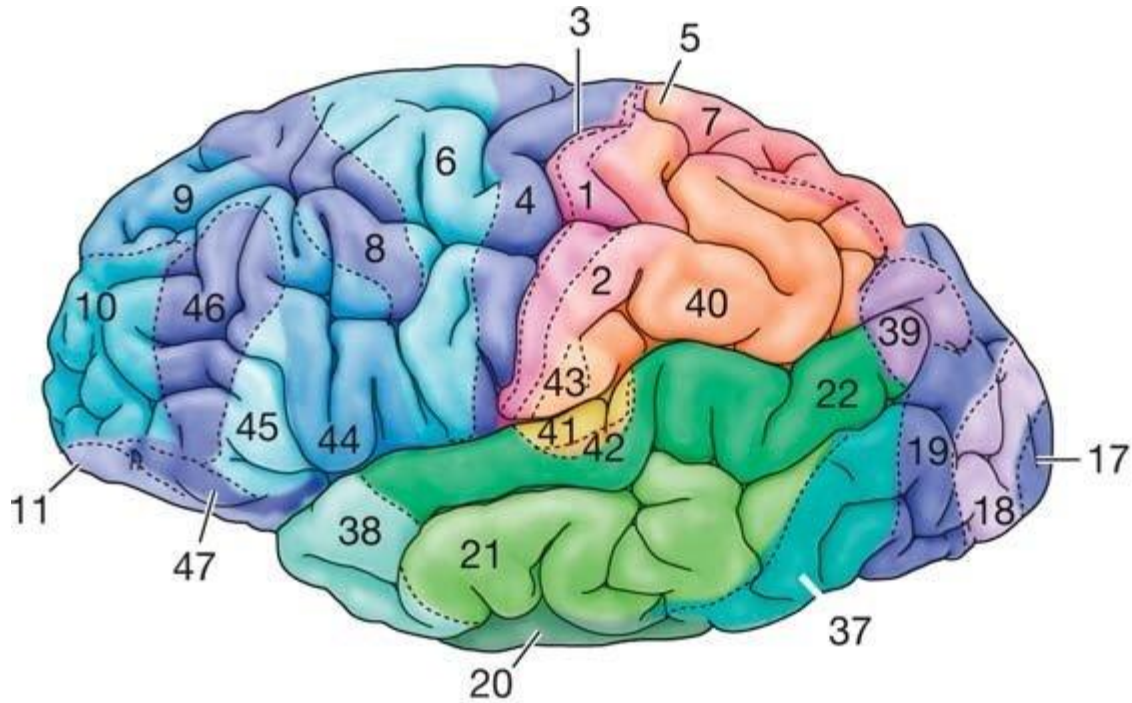
- Regions of the brain that are distinguishable based on their cellular composition.
- Often the physical differences in cell make-up correspond to functional differences such that different areas process different kinds of information – or the same information differently.





- Primary – basic processing of most elemental input (e.g., lines)
- Secondary/Association – elaborative processing (e.g., shapes, objects)
- Association/Heteromodal – Integrative processing (i.e., how you feel about an object, memories of the object)

Brodmann's Areas



More complex and nuanced processing.

Larger receptive fields as multiple cells converge onto smaller numbers of cells (integrative)

- Somatosensory Cortices

1. Initial processing with sharp representations
 - Area 3a – Muscle stretch receptors. Edge and position
 - Area 3b – Size and shape. Projects to Areas 1 & 2
2. Slightly more abstract
 - Area 1 – Texture
 - Area 2 – Motion, direction, orientation
3. Integrate Information
 - Areas 5 & 7

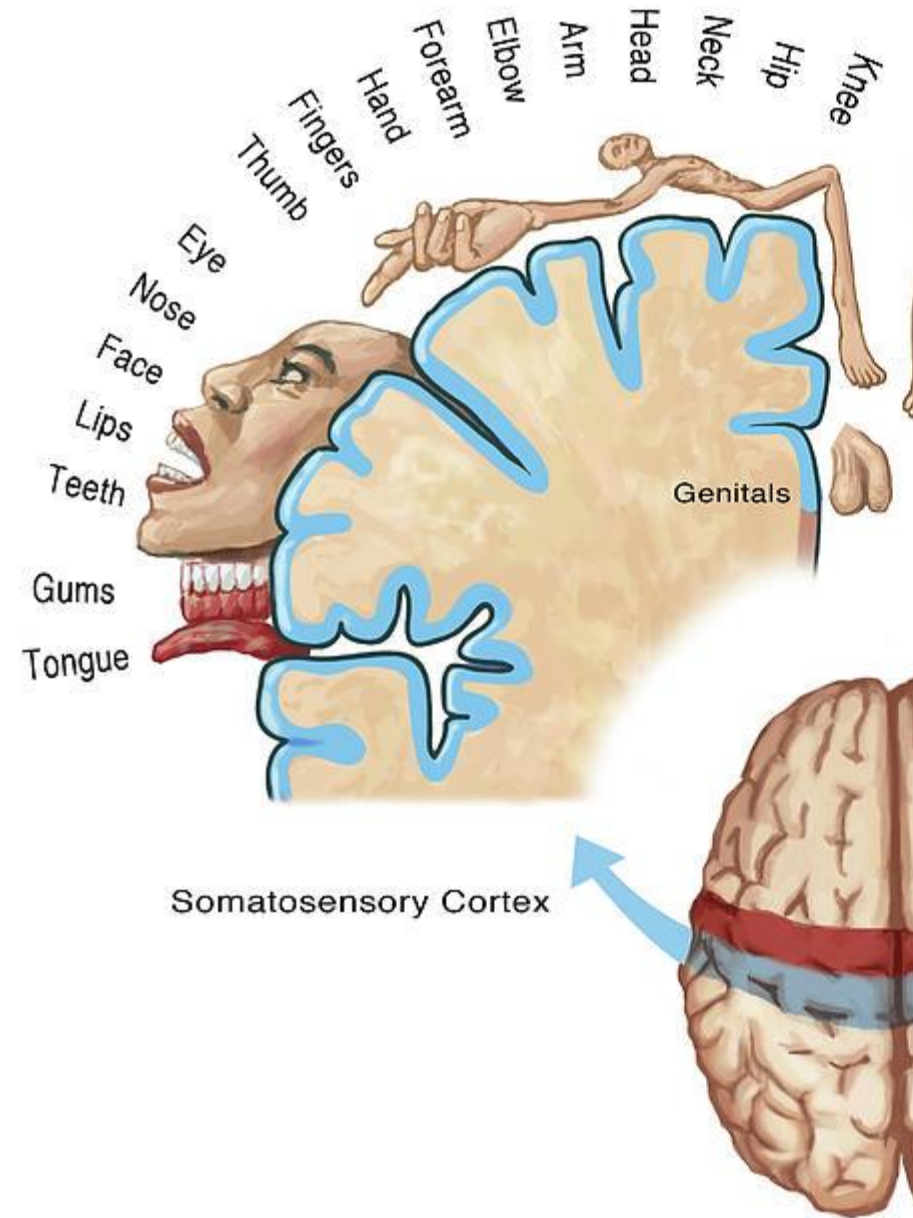
Somatotopic Map - projection of body surface onto brain area

Wade Marshall experiments (1930s)

- Cats and monkeys
- Touch a specific part of the body surface and produce an evoked potential
- Evoked potentials – recorded signals that represent summed activity of thousands of cells

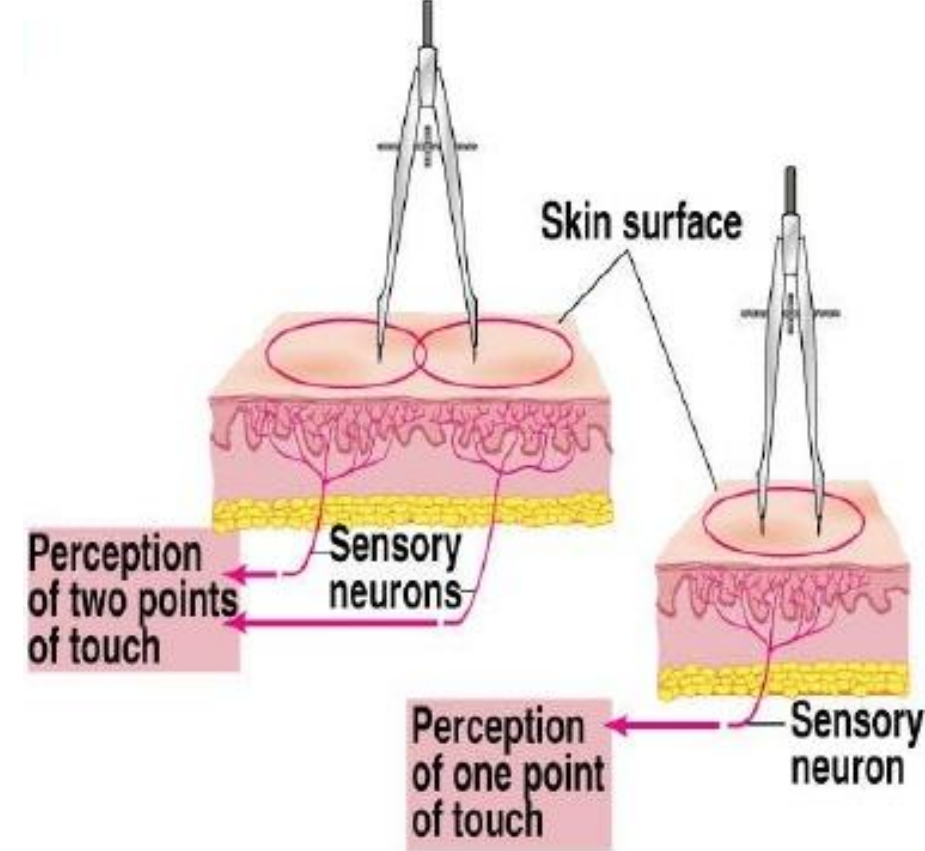
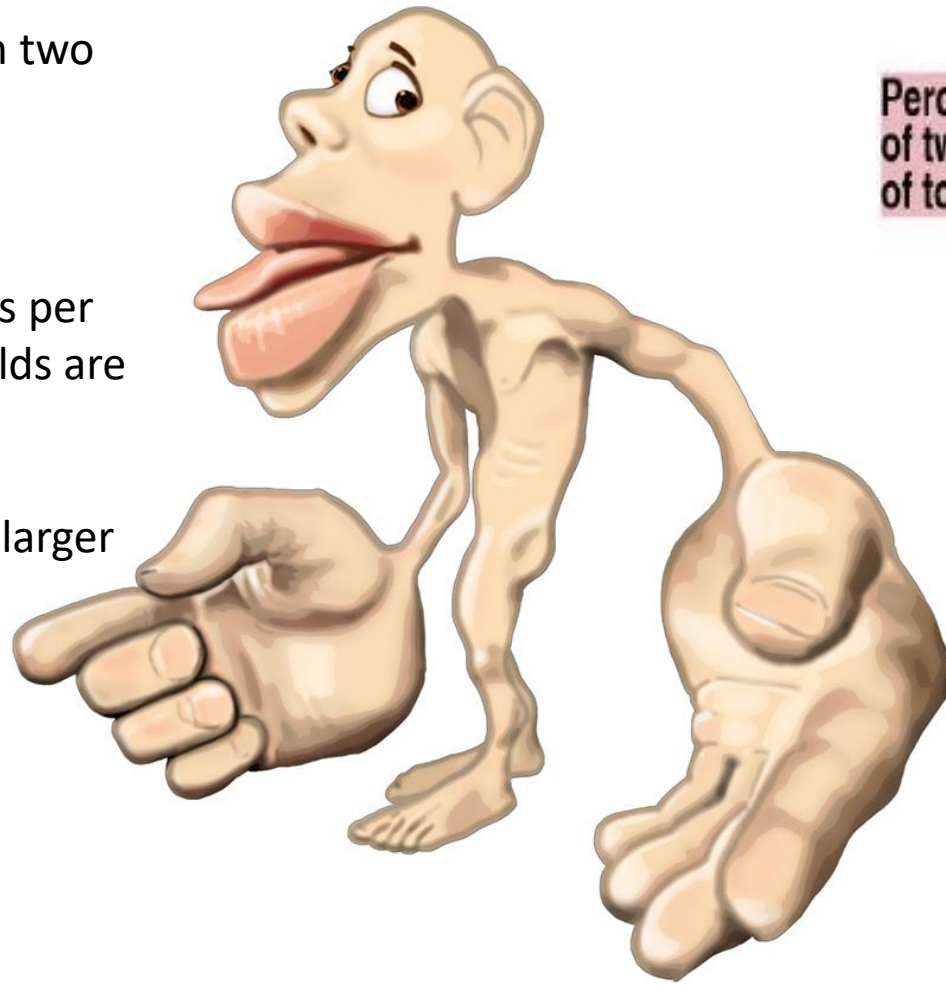
Wilder Penfield

- Pts with epilepsy and other brain disorders
- When a point on the cortex is stimulated you perceive it on the corresponding receptive field on your skin.



Two-Point Threshold

- Minimum distance at which two points can be perceived as separate
- Measures the distance between two receptive fields
- Finger tips have ~2,500 receptors per square centimeter. Receptive fields are ~3-4mm
- Trunk receptive fields are ~100x larger



Areas 3a, 3b, 1, & 2 each have distinct maps.



