Central Representation of Touch

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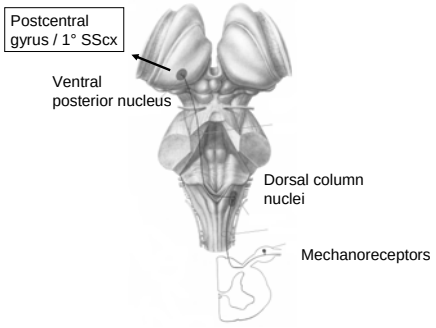
Mechanosensation

- Touch and tactile exploration
- Vibration and pressure sensations; important for clinical testing
- Limb position sense
- ∑ Stereognosia: identify 3-D shapes of grasped objects

Dorsal column-medial lemniscal system



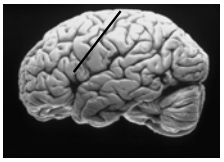
NTA 5-1

1 Somatotopic organization
2 Receptive field structure: key properties for tactile acuity
3 Other functions of inhibition
4 Cortical columns, submodality representation, and cortical mechanisms for higher somatic sensory functions
5 Elaboration of somatic sensory processing in higher-order sensory and association areas

Somatotopic Organization

- Preserves neighborhood relations
- Like a slide projector
  - Slide=peripheral receptive sheet
  - Light=peripheral and central pathways
  - Screen=central nervous system representation
- All processing stages and tracts in touch pathway are somatotopically organized
- Similar organization for vision (retinotopic) and auditory system (tonotopic)

Wilder Penfield

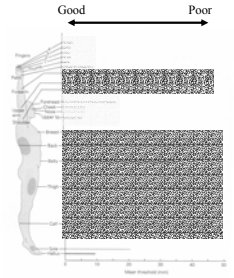


What does the homunculus in the postcentral gyrus tell us about somatic sensory processing?

…stimulus localization & discrimination

PNS 20-4

2 Point Discrimination

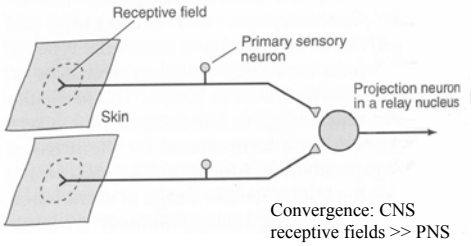


What is the basis of distortions in the cortical homunculus?

…receptive field structure

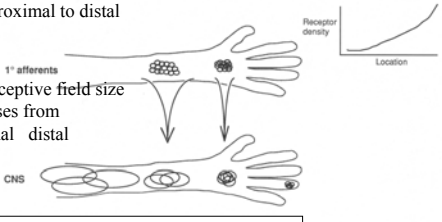
PNS 22-5

CNS neurons have receptive fields



Convergence: CNS receptive fields >> PNS receptive fields

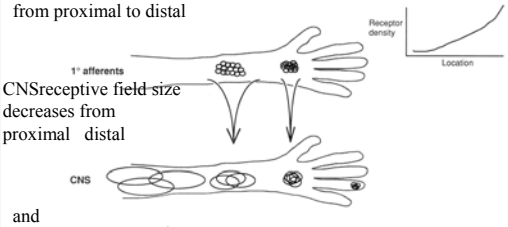
Receptor innervation density increases from proximal to distal



CNSreceptive field size decreases from proximal distal

and overlap increases

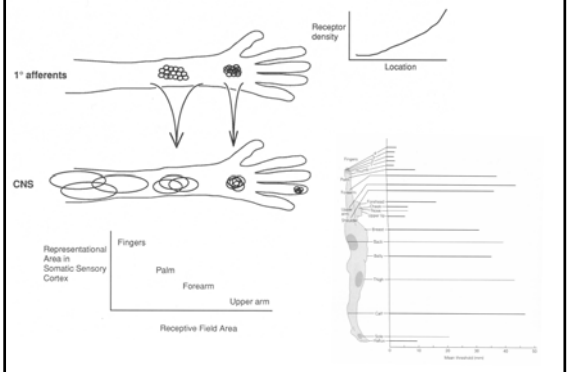
Receptor innervation density increases from proximal to distal



CNSreceptive field size decreases from proximal distal

and overlap increases

Representational area inversely proportional to RF area

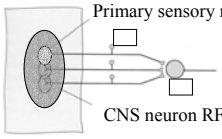


Map distortions reflect genetics and experience

PNS 20-5

•Somatotopic organization
•**Receptive field structure: key properties for tactile acuity**
•**Other functions of inhibition**
•**Cortical columns, submodality representation, and cortical mechanisms for higher somatic sensory functions**
•**Elaboration of somatic sensory processing in higher-order sensory and association areas**

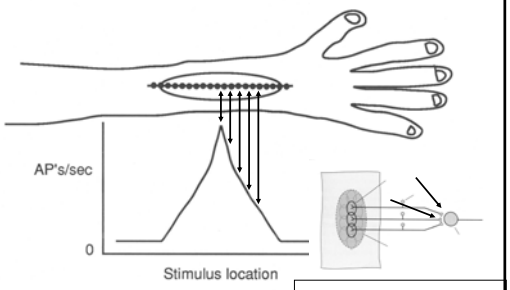
Receptive field



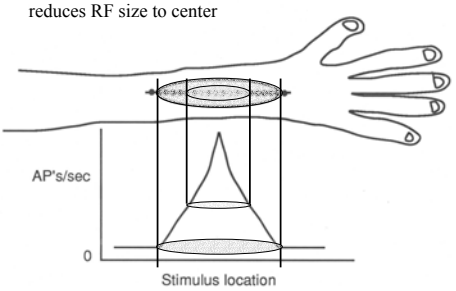
Structural basis of RF: distribution of sensory fiber innervation

PNS 23-10

Gradient of excitation within excitatory RF in CNS neurons

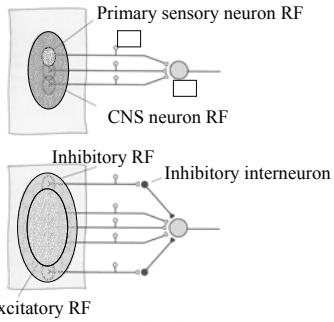


Gradient of excitation effectively reduces RF size to center

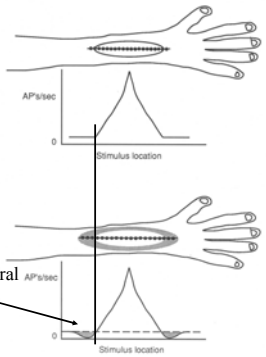


…RF area increases with stronger stimuli; not veridical

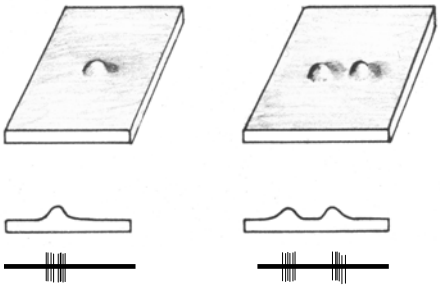
Receptive field structure



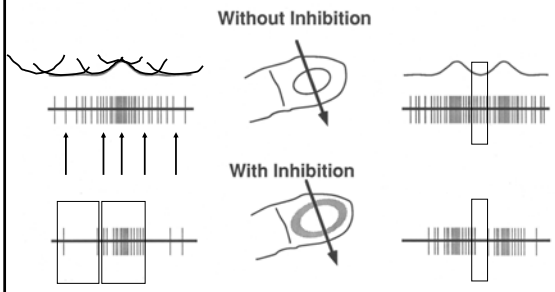
PNS 23-10



Increase signal-to-noise ratio



Mechanoreceptor response

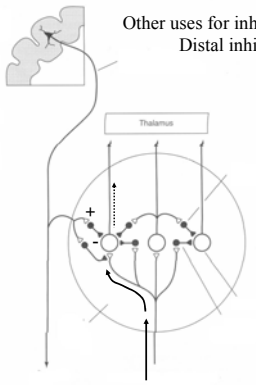


CNS neuron response to stimulus

Receptive Field Structure

- Gradient of + sharpens neural response to center of RF, which is most sensitive
- Inhibitory RF turns neuron off before it is activated by stimulus, thereby increasing S/N

Other uses for inhibition in sensory systems:
Stimulus feature extraction



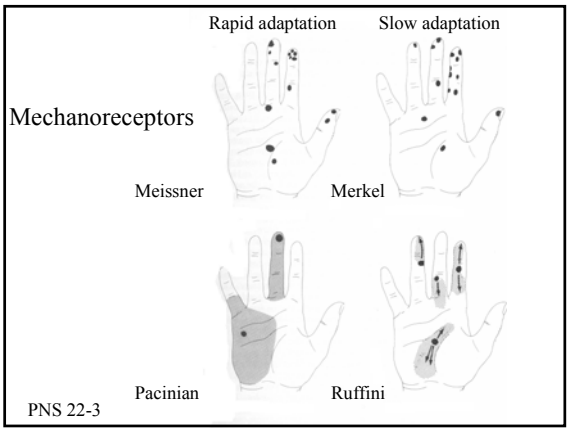
Other uses for inhibition in sensory systems:
Distal inhibition--usually top down

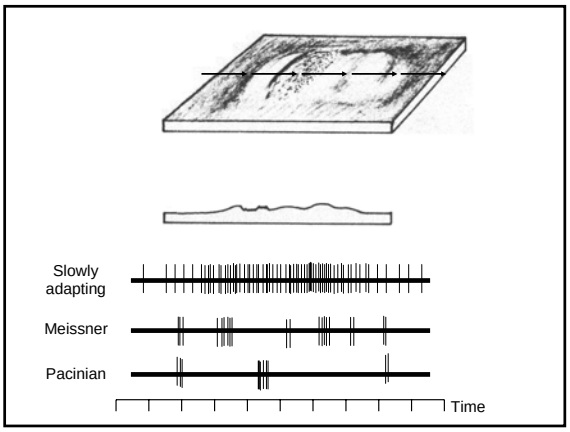
Cortical neuron excites inhibitory interneuron

Inhibitory interneuron inhibits projection neuron in nucleus

Effect: reduces transmission through nucleus
FINE TUNE

How is information from different mechanoreceptors represented in primary somatic sensory cortex?

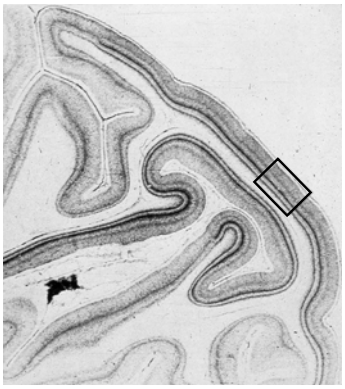




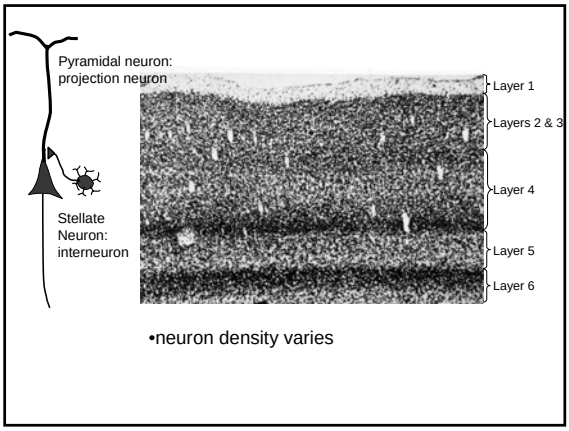
Texture code:

- Different receptors respond to different components of complex stimulus
- Internal representation of a texture determined by activity in population of diverse mechanoreceptors

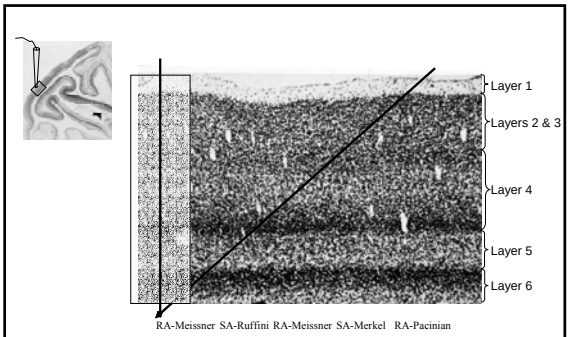
How is receptor information represented in the primary somatic sensory cortex?



- Cell-stained section (Nissl)
- most 6 cell layers



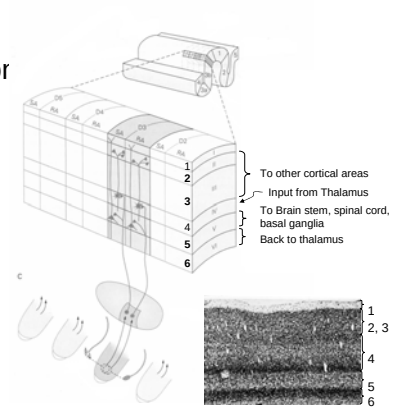
•neuron density varies



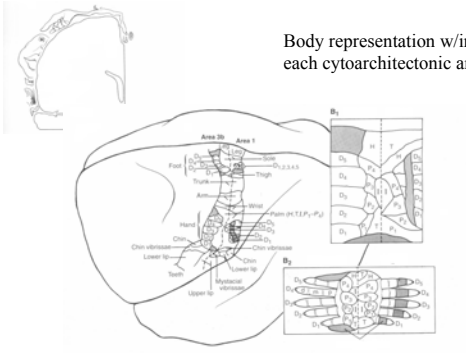
Columnar organization
- •same receptor
- •same location

Different textures produce different column activation patterns

Columnar organization of 1° SScx



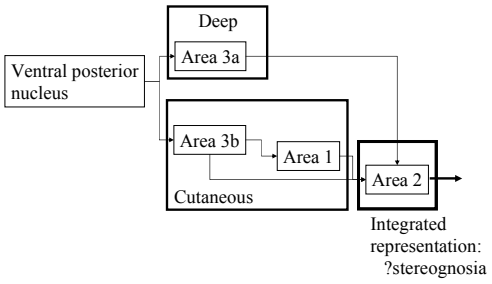
PNS 23-6,7



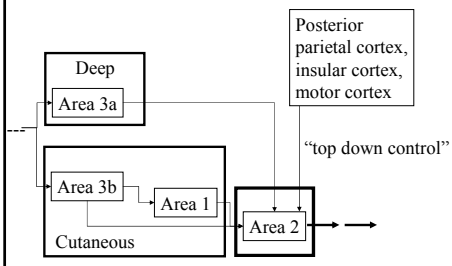
Body representation w/in each cytoarchitectonic area

PNS 20-6

Processing mechanoreceptive information within the Primary Somatic Sensory Cortex



Processing mechanoreceptive information within the Primary Somatic Sensory Cortex



Summary

- Touch path has hierarchical organization
  - Not bucket brigade
  - Message transformed
- Several mechanisms for enhancing spatial acuity
  - Gradient of excitation
  - Surround inhibition
- Columnar organization of cortex
  - Same input (receptor and location)
- Intracortical processing leads to integrated representation

Conclusions

- Bottom up
  - Receptors to spinal cord to cortex
- Top down
  - Cortex to subcortical centers - Layers 5, 6
  - Other cortical areas project into somatic sensory cortex
- Result
  - Experience and expectation modulates stimulus processing, both subcortically in relay nuclei and in cortex
    - illusions
  - Pathological states can generate sensation *de novo*
    - halucinations