

# Central Representation of Touch

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## Mechanosensation

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

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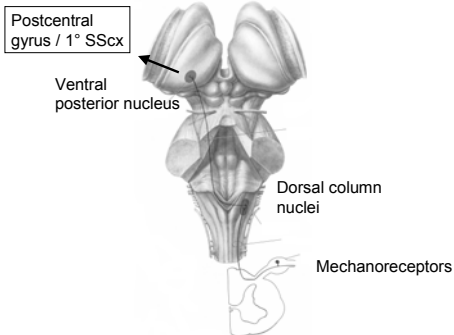
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### Dorsal column-medial lemniscal system



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- 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

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## 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)

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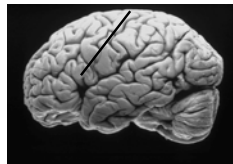
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## Wilder Penfield



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

...stimulus localization & discrimination

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### 2 Point Discrimination



What is the basis of distortions in the cortical homunculus?  
 ...receptive field structure

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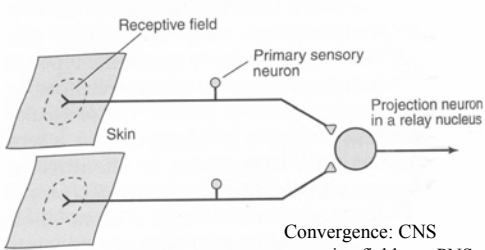
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### CNS neurons have receptive fields



Convergence: CNS receptive fields >> PNS receptive fields

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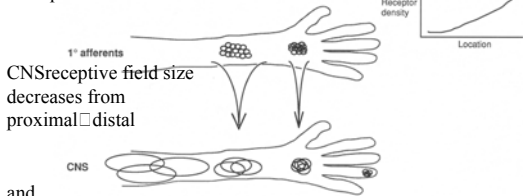
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Receptor innervation density increases from proximal to distal



and overlap increases

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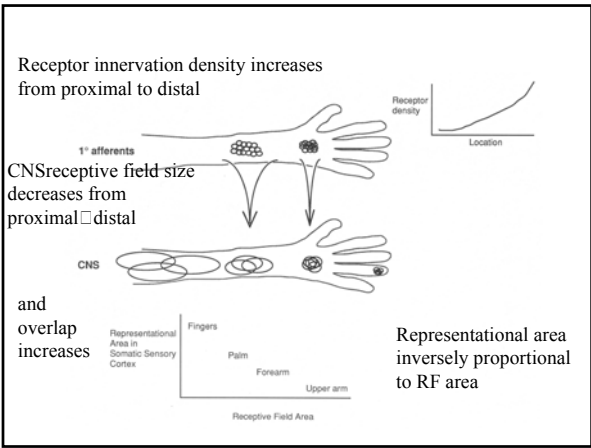
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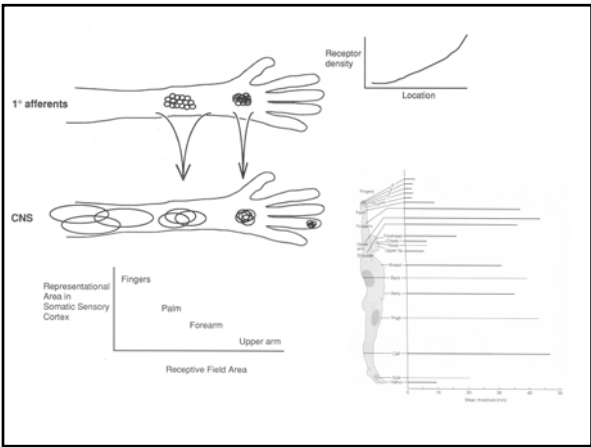
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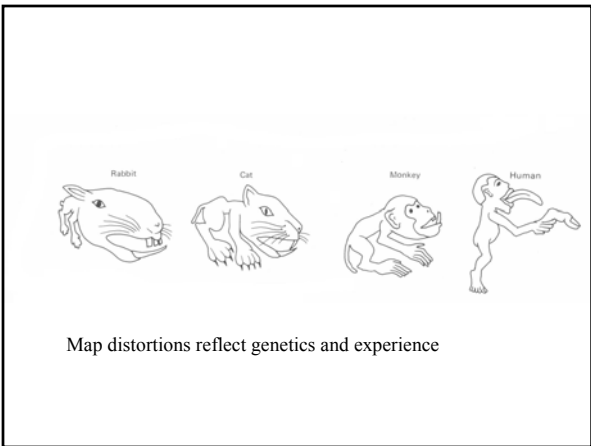
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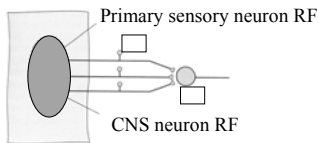
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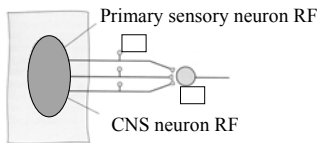
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### Receptive field



Structural basis of RF: distribution of sensory fiber innervation

### Receptive field structure




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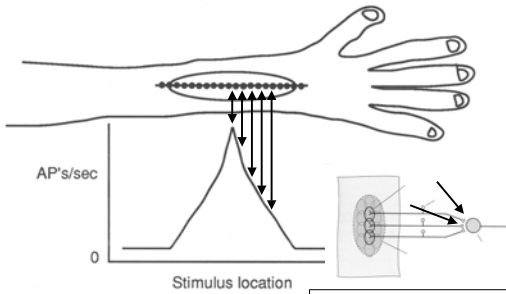
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### Gradient of excitation within excitatory RF in CNS neurons




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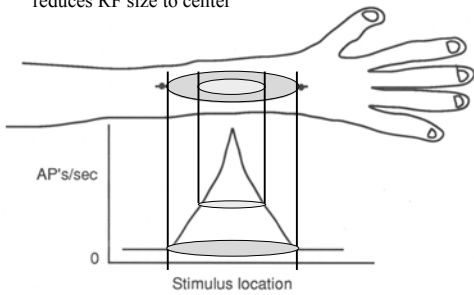
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### Gradient of excitation effectively reduces RF size to center



...RF area increases with stronger stimuli; not veridical

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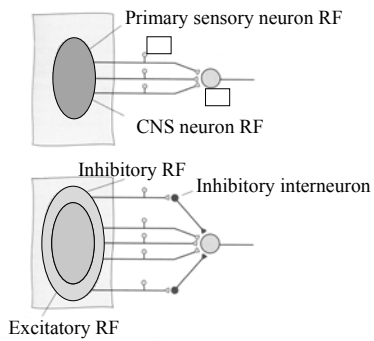
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### Receptive field structure




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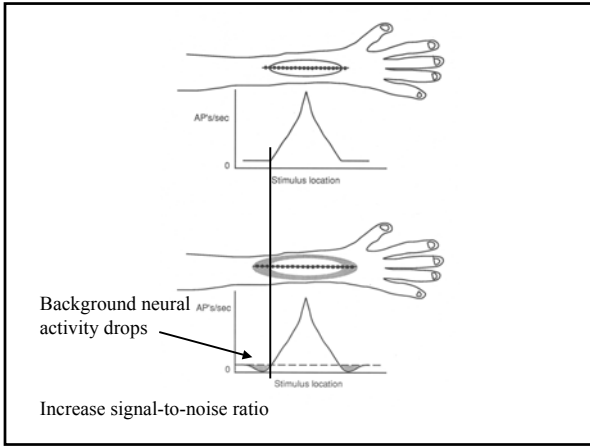
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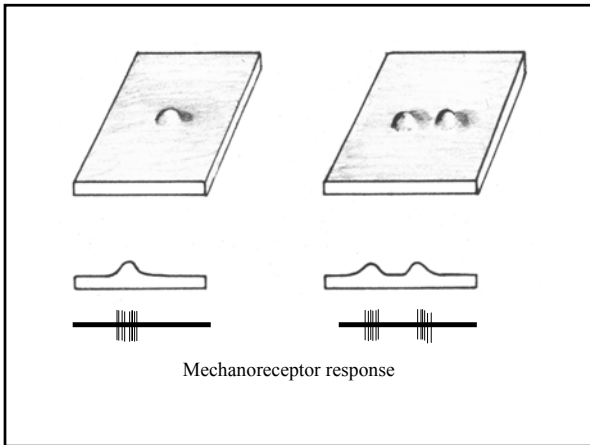
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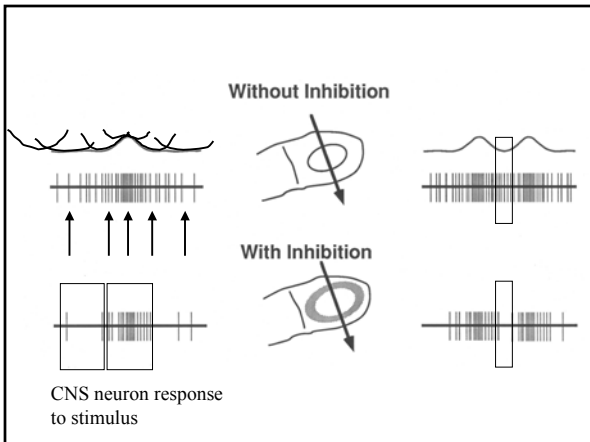
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## Receptive Field Structure

- 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

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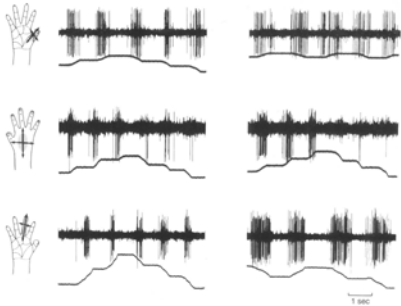


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Other uses for inhibition in sensory systems:  
Stimulus feature extraction




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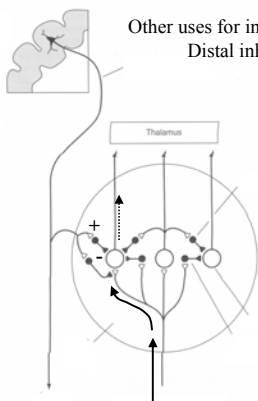


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Other uses for inhibition in sensory systems:  
Distal inhibition--usually top down



Cortical neuron excites inhibitory interneuron  
Inhibitory interneuron inhibits projection neuron in nucleus  
Effect: blocks or fine-tunes transmission through nucleus

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

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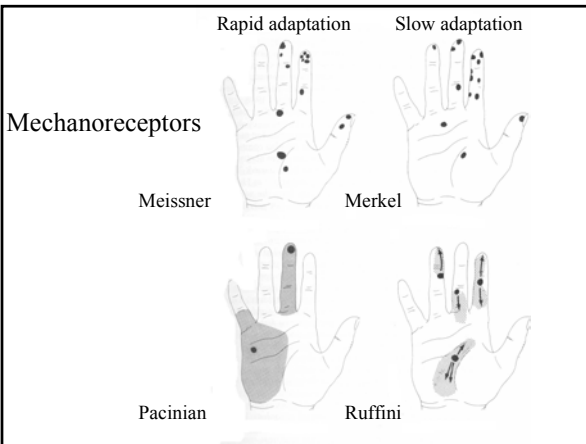
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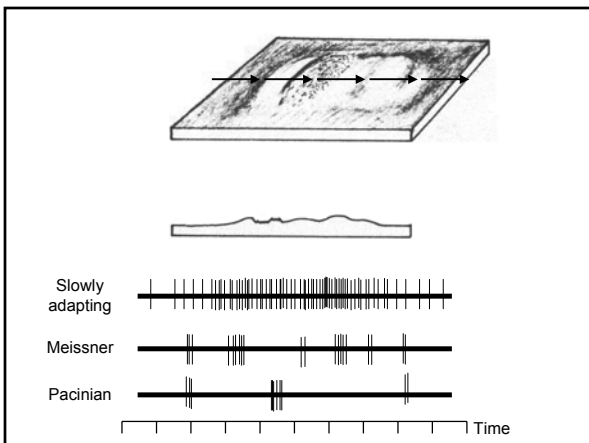
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## Texture code:

- 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?**

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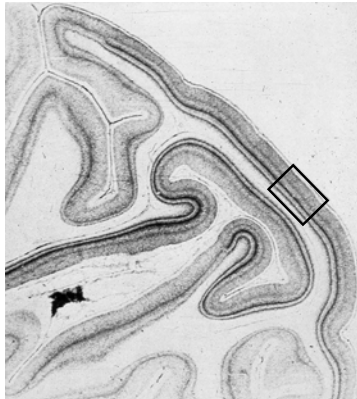
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- Cell-stained section (Nissl)
- most 6 cell layers

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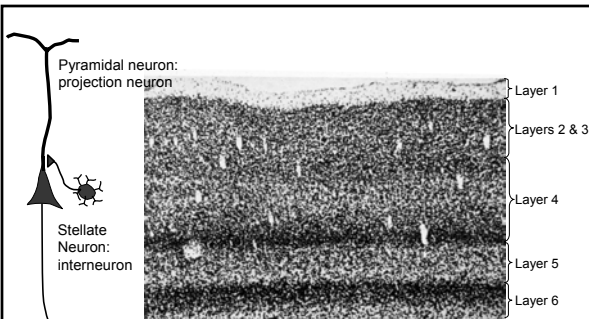
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•neuron density varies

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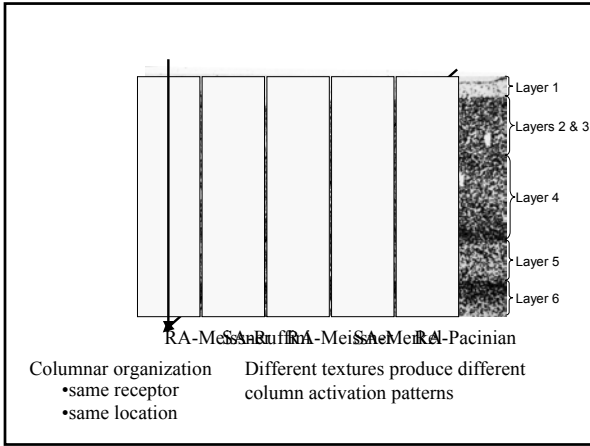
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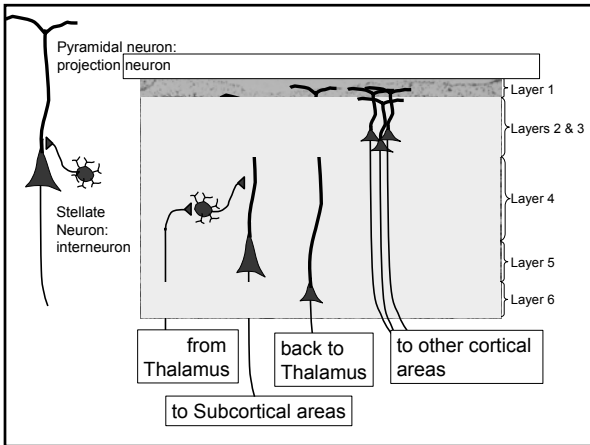
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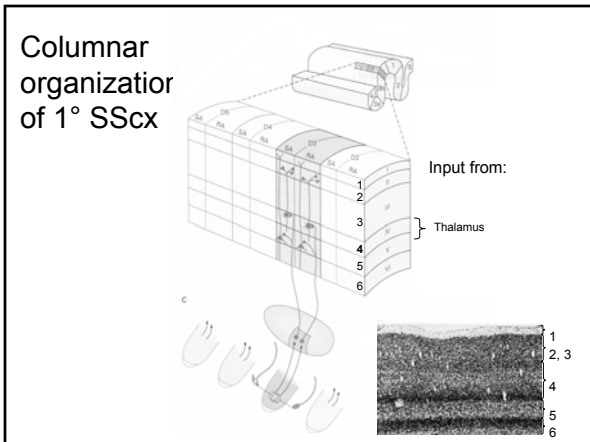
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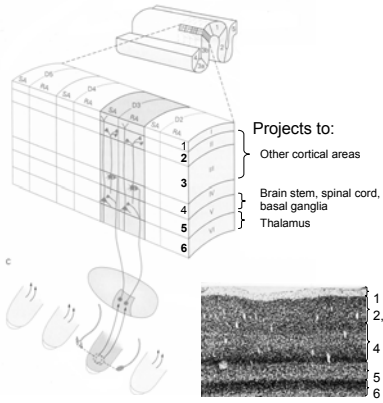
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# Columnar organization of 1° SScx




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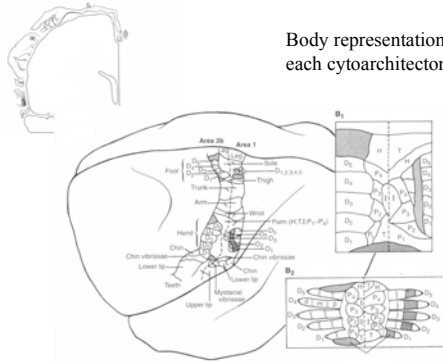
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# Body representation w/in each cytoarchitectonic area




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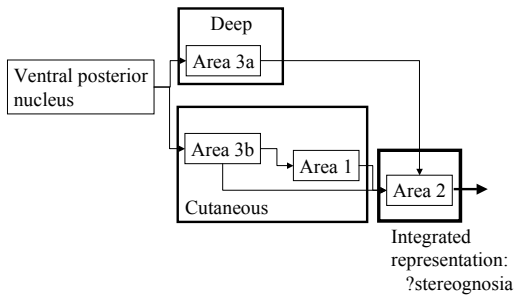
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# Processing mechanoreceptive information within the Primary Somatic Sensory Cortex




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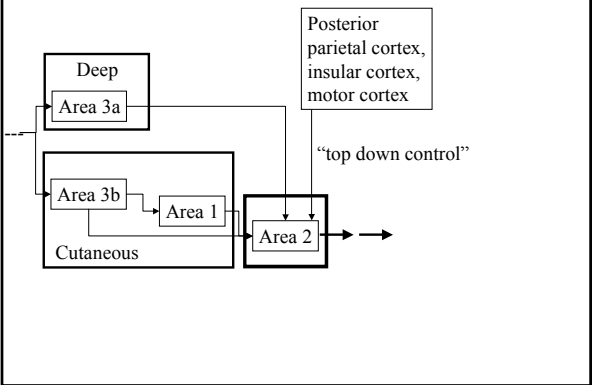
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Processing mechanoreceptive information within the Primary Somatic Sensory Cortex




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## 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

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## 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*
    - hallucinations

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