www.hawkeyecollege.edu/faculty/sdinsmore/A&PI/Export%20Folder10-13/chapter12/PowerPoint/chapter_12_powerpoint_l.ppt

Nervous System - Senses

General Senses

- receptors that are widely distributed throughout the body
- skin, various organs and joints

Special Senses

- specialized receptors confined to structures in the head
- eyes and ears

Senses

Sensory Receptors

- specialized cells or multicellular structures that collect information from the environment
- stimulate neurons to send impulses along sensory fibers to the brain

Sensation (감각)

- a feeling that occurs when brain becomes aware of sensory impulse

Perception (지각)

- a person's view of the stimulus; the way the brain interprets the information

Pathways From Sensation to Perception (Example of an Apple)

TABLE 12.1 Information Flow from the Environment Through the Nervous System

Information Flow	Smell	Taste	Sight	Hearing
Sensory receptors	Olfactory cells in nose	Taste bud receptor cells	Rods and cones in retina	Hair cells in cochlea
↓	↓	↓	↓	↓
Impulse in sensory fibers	Olfactory nerve fibers	Sensory fibers in various cranial nerves	Optic nerve fibers	Auditory nerve fibers
↓	↓	↓	↓	↓
Impulse reaches CNS	Cerebral cortex	Cerebral cortex	Midbrain and cerebral cortex	Midbrain and cerebral cortex
↓	↓	↓	↓	↓
Sensation (new experience, recalled memory)	A pleasant smell	A sweet taste	A small, round, red object	A crunching sound
↓	↓	↓	↓	↓
Perception	The smell of an apple	The taste of an apple	The sight of an apple	Biting into an apple

Receptor Types

Chemoreceptors

- respond to changes in chemical concentrations

Pain receptors (Nociceptors)

- respond to tissue damage

Thermoreceptors

- respond to changes in temperature

Mechanoreceptors

- respond to mechanical forces

Photoreceptors

- respond to light

Sensory Impulses

• stimulation of receptor causes local change in its receptor potential

• a graded electrical current is generated that reflects intensity of stimulation

• if receptor is part of a neuron, the membrane potential may generate an action potential

• if receptor is not part of a neuron, the receptor potential must be transferred to a neuron to trigger an action potential

• peripheral nerves transmit impulses to CNS where they are analyzed and interpreted in the brain

Sensations

Projection

process in which the brain projects the sensation back to the apparent source

it allows a person to pinpoint the region of stimulation

Sensory Adaptation

- ability to ignore unimportant stimuli

- involves a decreased response to a particular stimulus from the receptors (peripheral adaptations) or along the CNS pathways leading to the cerebral cortex (central adaptation)

- sensory impulses become less frequent and may cease

- stronger stimulus is required to trigger impulses

General Senses

- senses associated with skin, muscles, joints, and viscera
- three groups
  - exteroceptive senses – senses associated with body surface; touch, pressure, temperature, pain
  - visceroceptive senses – senses associated with changes in viscera; blood pressure stretching blood vessels, ingesting a meal
  - proprioceptive senses – senses associated with changes in muscles and tendons

Touch and Pressure Senses

Free nerve endings

- common in epithelial tissues
- simplest receptors
- sense itching

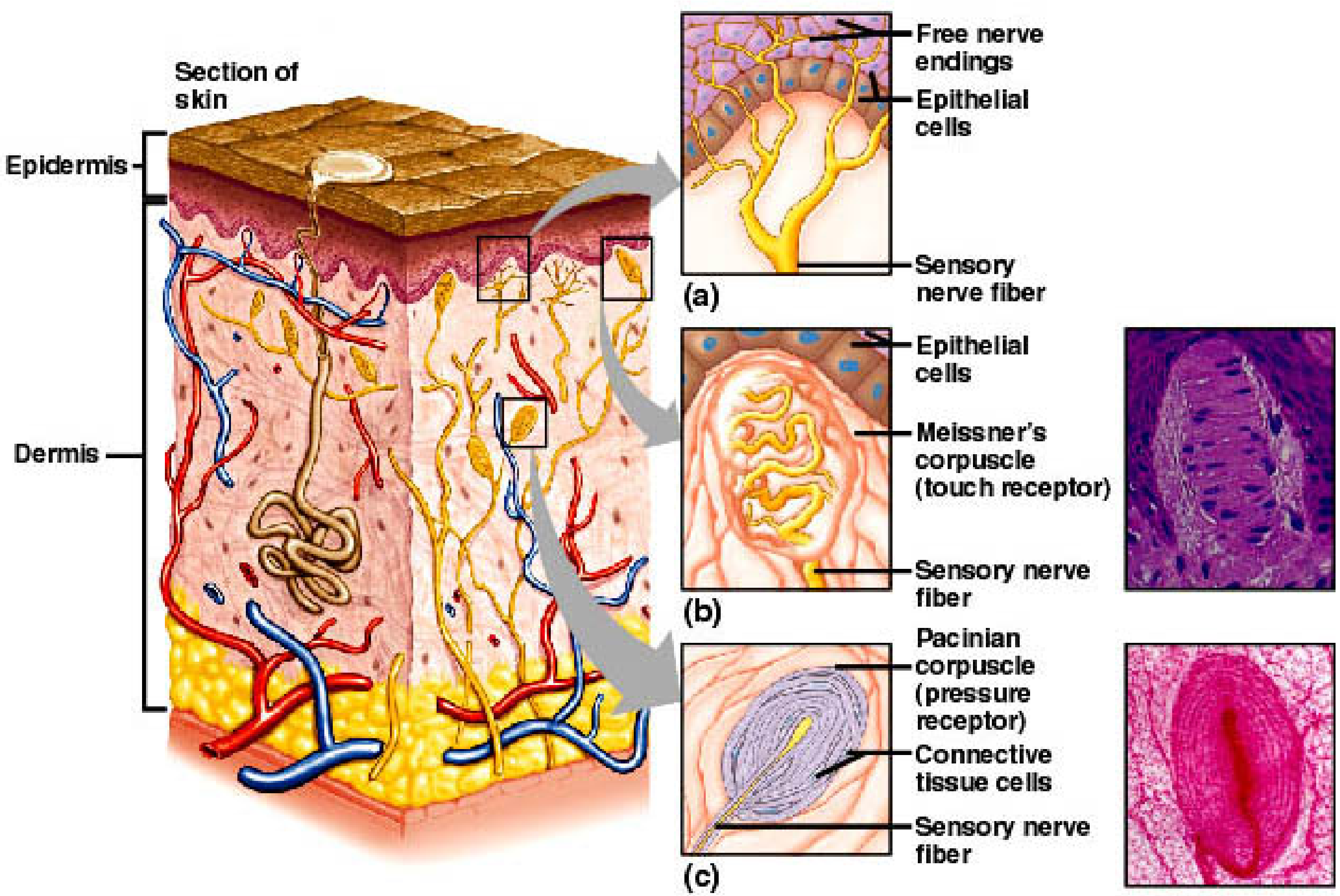
Meissner's corpuscles (touch receptor)

- abundant in hairless portions of skin; lips
- detect fine touch; distinguish between two points on the skin

Pacinian corpuscles (pressure receptor)

- common in deeper subcutaneous tissues, tendons, and ligaments
- detect heavy pressure and vibrations

Touch and Pressure Receptors



Temperature Senses

Warm receptors

- sensitive to temperatures above 25^{o}C (77^{o} F)
- unresponsive to temperature above 45^{o}C (113^{o}F)

Cold receptors

- sensitive to temperature between 10^{o}C (50^{o}F) and 20^{o}C (68^{o}F)

Pain receptors

- respond to temperatures below 10^{o}C
- respond to temperatures above 45^{o}C

Sense of Pain

- free nerve endings (pain receptors)

Free nerve endings can detect temperature, mechanical stimuli (touch, pressure, stretch) or pain (nociception). Thus, different free nerve endings work as thermoreceptors, cutaneous mechanoreceptors and nociceptors.

- widely distributed
- nervous tissue of brain lacks pain receptors
- stimulated by tissue damage, chemical, mechanical forces, or extremes in temperature
- adapt very little, if at all

Visceral Pain

- pain receptors are the only receptors in viscera whose stimulation produces sensations

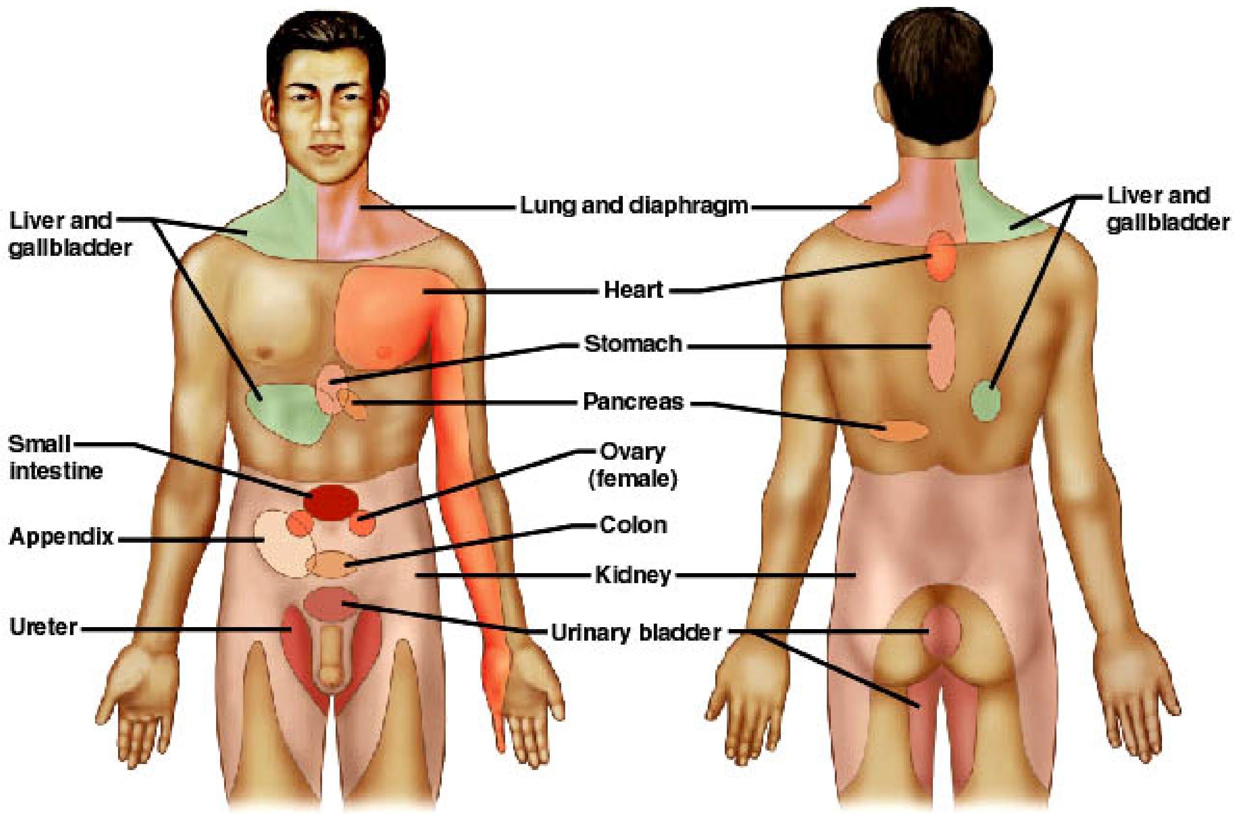
- pain receptors respond differently to stimulation

- not well localized

- may feel as if coming from some other part of the body
    - known as referred pain

Referred Pain

• may occur due to sensory impulses from two regions following a common nerve pathway to brain



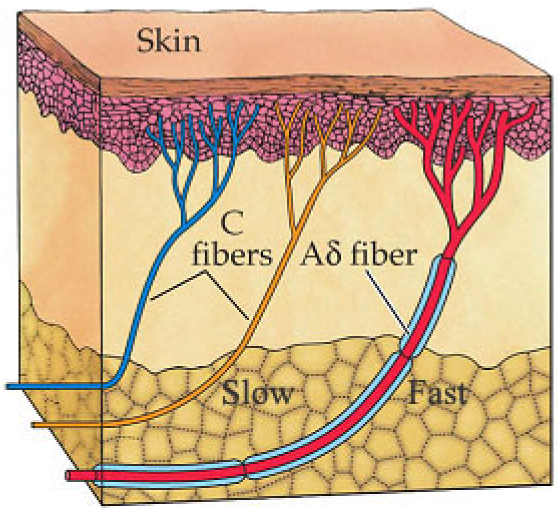
Pain Nerve Pathways

Acute pain fibers

- A-delta fibers
- thick, myelinated
- conduct impulses rapidly
- associated with sharp pain
- well localized

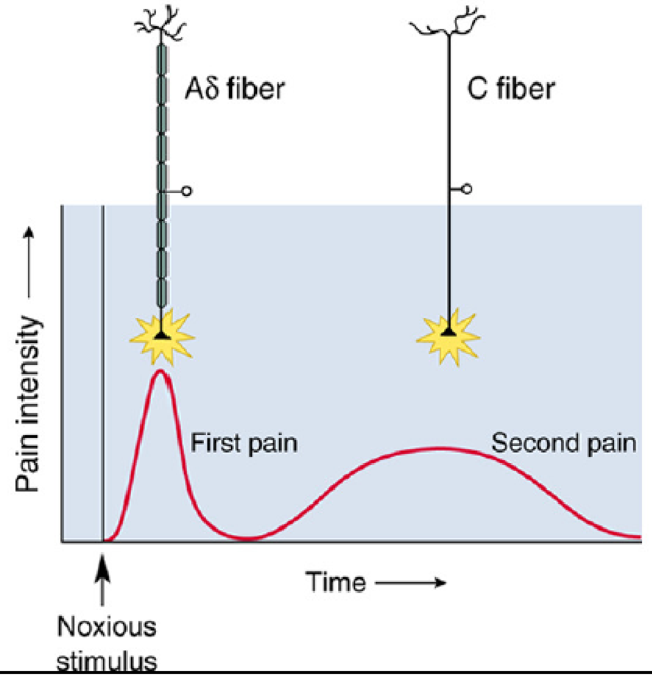
Chronic pain fibers

- C fibers
- thin, unmyelinated
- conduct impulses more slowly
- associated with dull, aching pain
- difficult to pinpoint



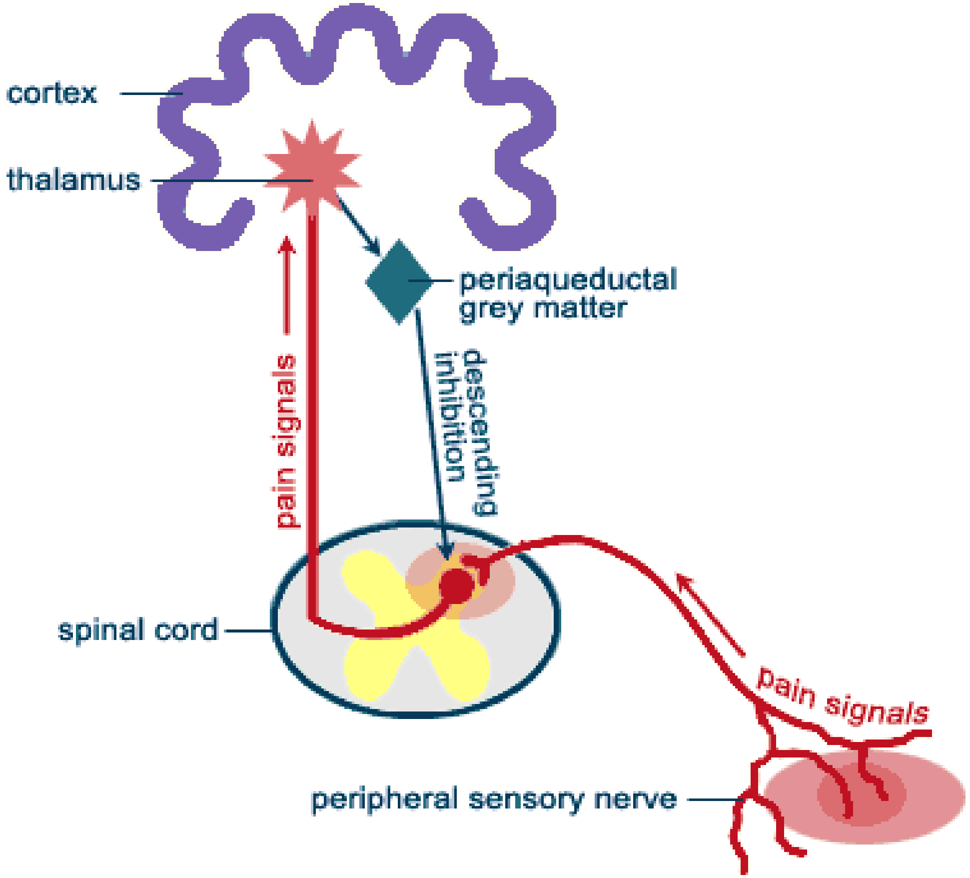
Pain

- Primary Afferents
  - First pain and second pain



While large mechanosensory neurons such as Aß display adaptation, smaller type C nociceptive neurons do not. As a result, pain does not usually subside rapidly but persists for long periods of time

Neural Pain Pathways



http://www.ccac.ca/en/CCAC_Programs/ETCC/Module10/07.html

Nociceptors - An Introduction to Pain
https://www.youtube.com/watch?v=fUKlpuz2VTs

Regulation of Pain Impulses

Thalamus

- allows person to be aware of pain

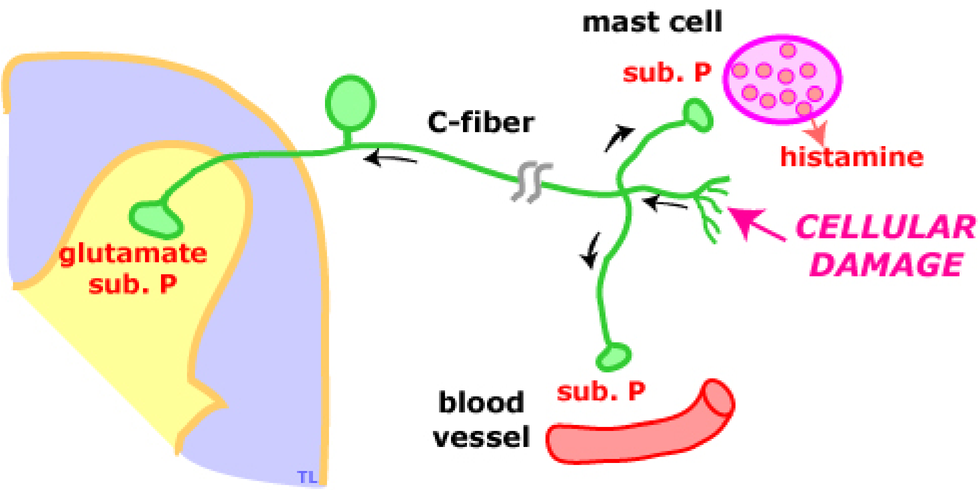
Cerebral Cortex

- judges intensity of pain
- locates source of pain
- produces emotional and motor responses to pain

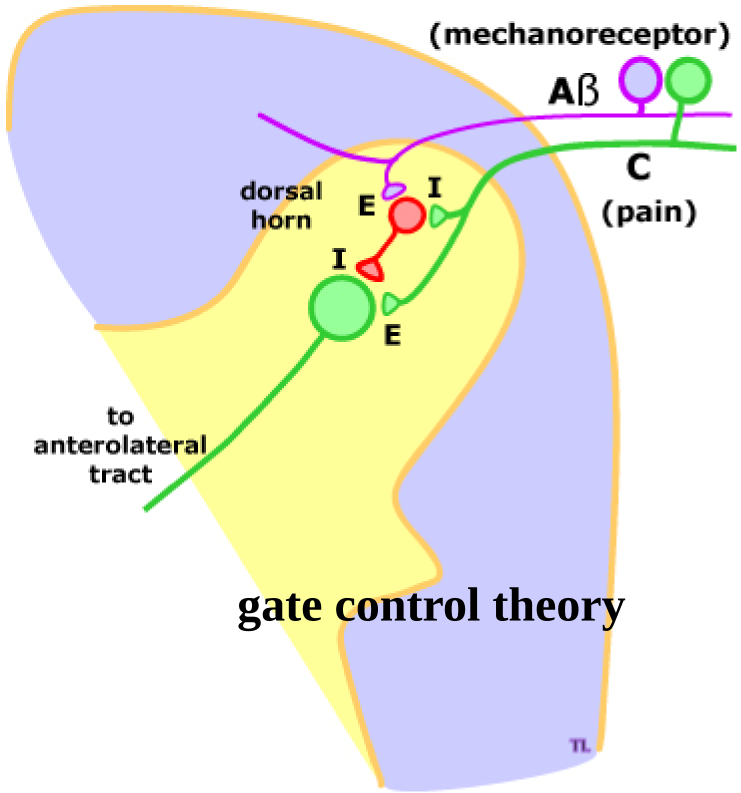
Pain Inhibiting Substances

- enkephalins
- serotonin
- endorphins

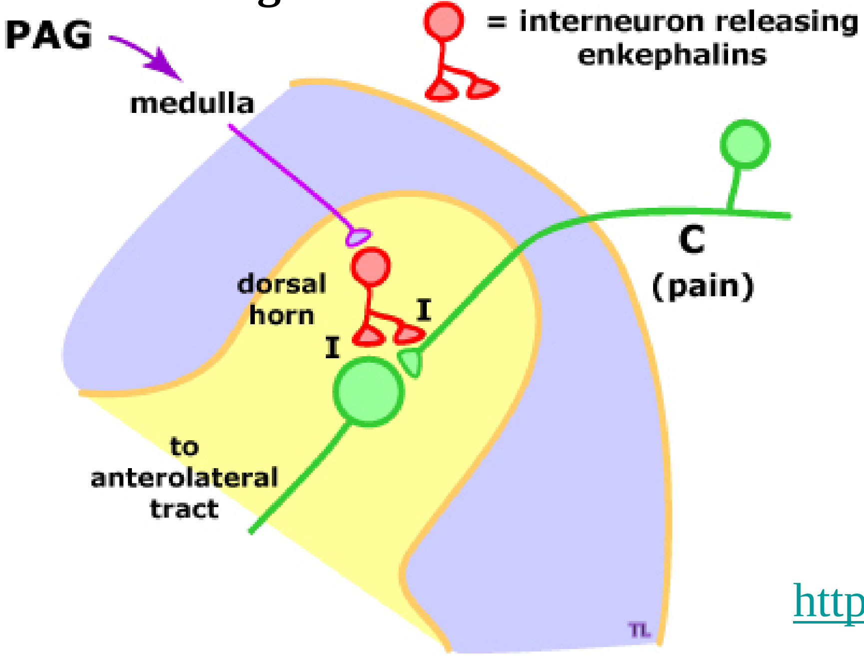
Hyperalgesia (Inflammation)



Reduction in the Perception of Pain



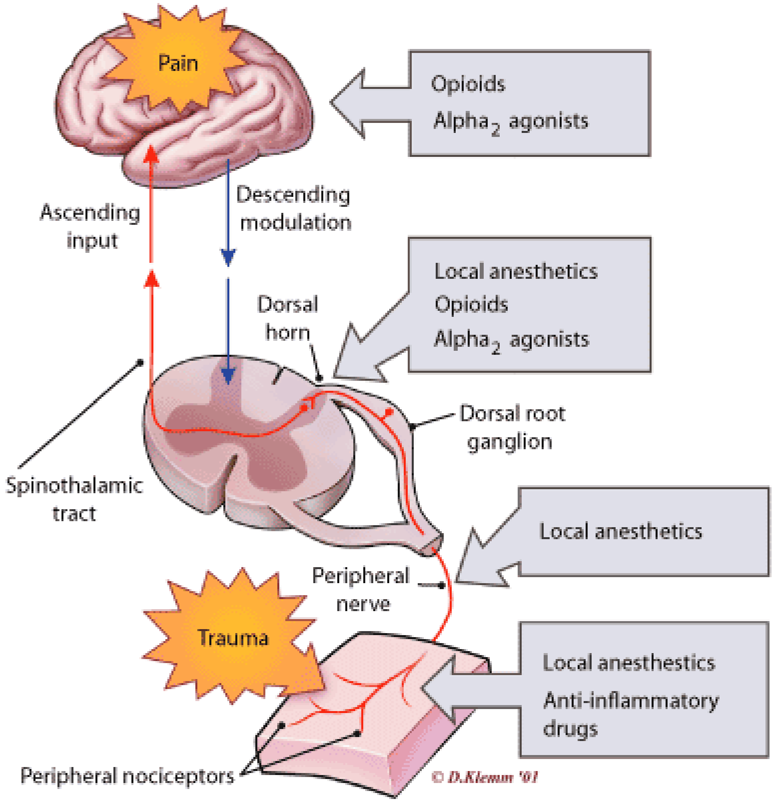
Analgesia



PAG: periaqueductal gray

http://courses.washington.edu/conj/sensory/pain.htm

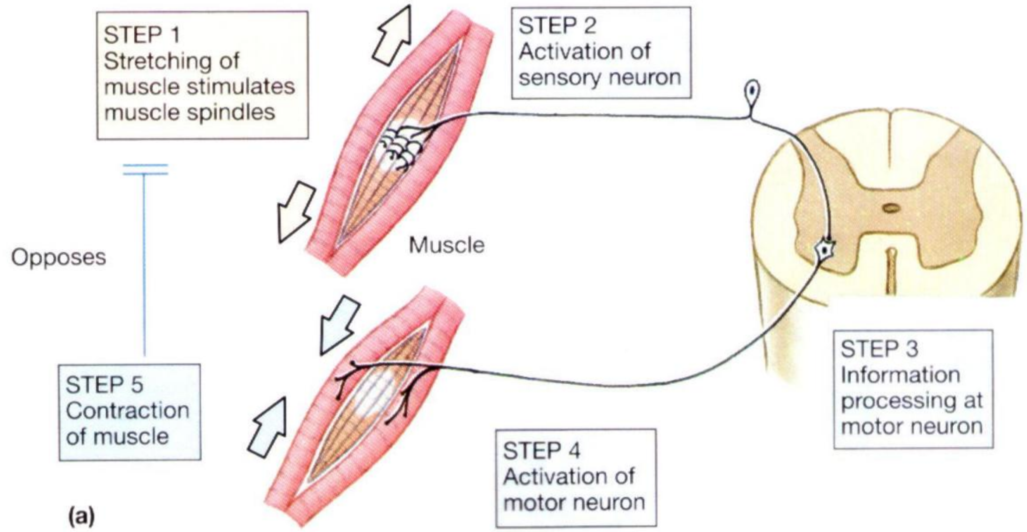
The pain pathway and interventions that can modulate activity at each point



Proprioceptors

- mechanoreceptors
- send information to spinal cord and CNS about body position and length and tension of muscles
- Main kinds of proprioreceptors
  - Pacinian corpuscles – in joints
  - muscle spindles – in skeletal muscles*
  - Golgi tendon organs – in tendons*

*stretch receptors



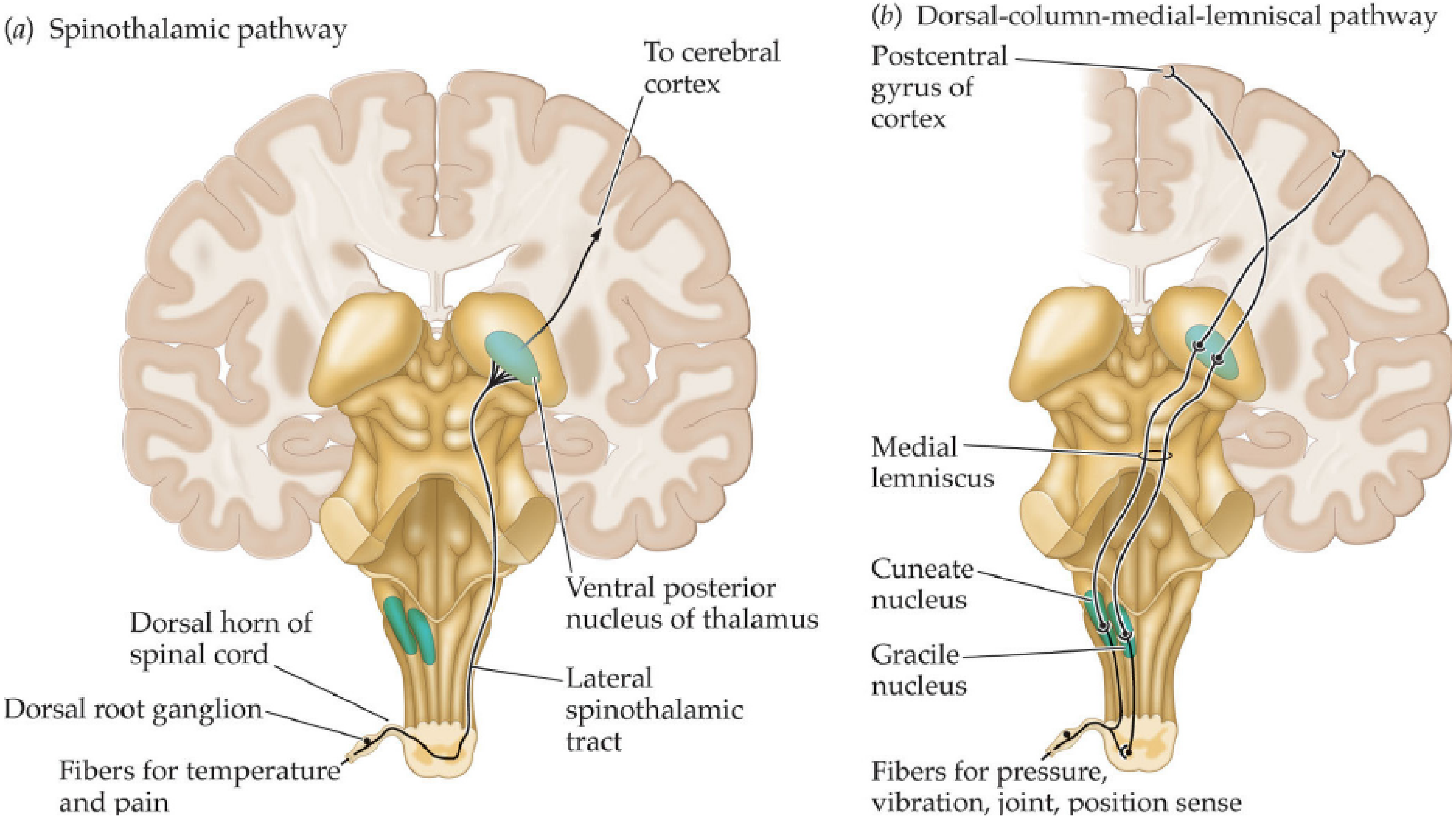
(a)

Summary of Receptors of the General Senses

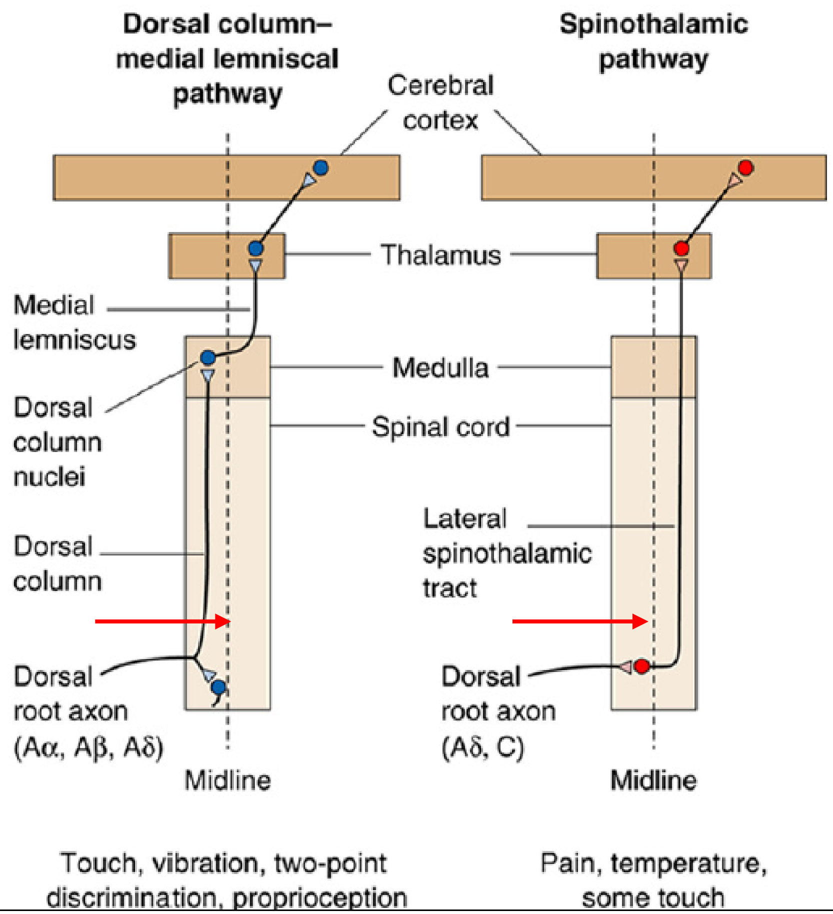
TABLE 12.2 Receptors Associated with General Senses

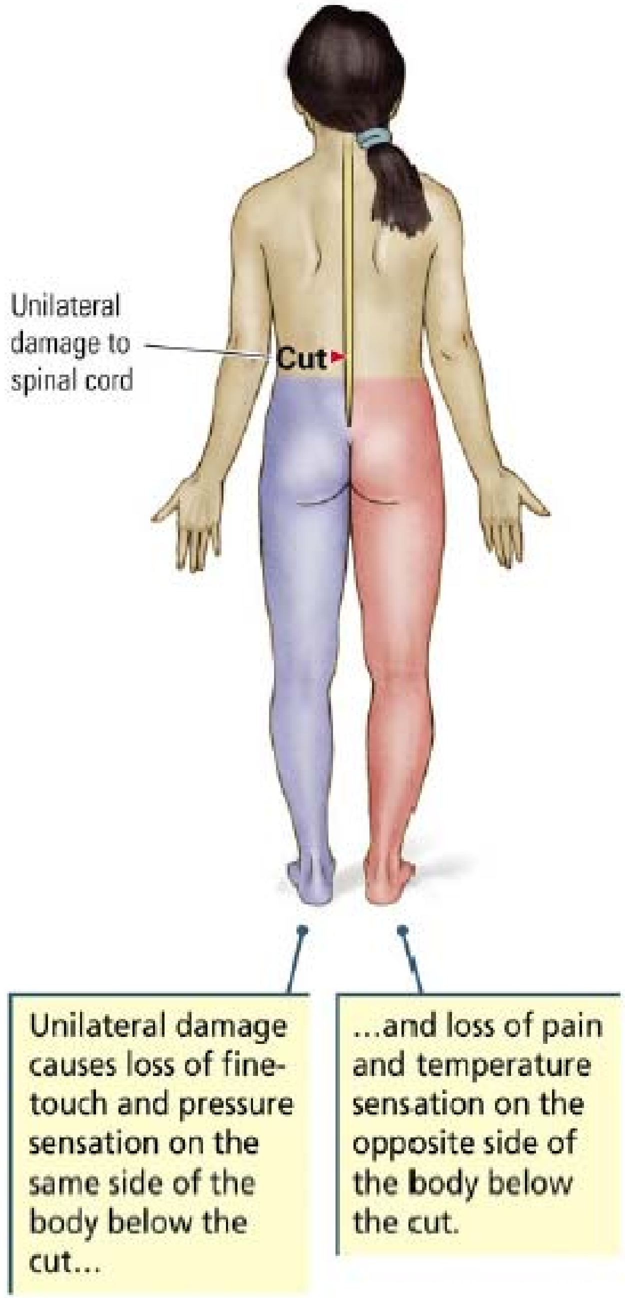
Type	Function	Sensation
Free nerve endings (mechanoreceptors)	Detect changes in pressure	Touch, pressure
Tactile corpuscles (mechanoreceptors)	Detect objects moving over the skin	Touch, texture
Lamellated corpuscles (mechanoreceptors)	Detect changes in pressure	Deep pressure, vibrations, fullness in viscera
Free nerve endings (thermoreceptors)	Detect changes in temperature	Heat, cold
Free nerve endings (pain receptors)	Detect tissue damage	Pain
Free nerve endings (mechanoreceptors)	Detect stretching of tissues, tissue spasms	Visceral pain
Muscle spindles (mechanoreceptors)	Detect changes in muscle length	None
Golgi tendon organs (mechanoreceptors)	Detect changes in muscle tension	None

Pathways from Skin to Cortex



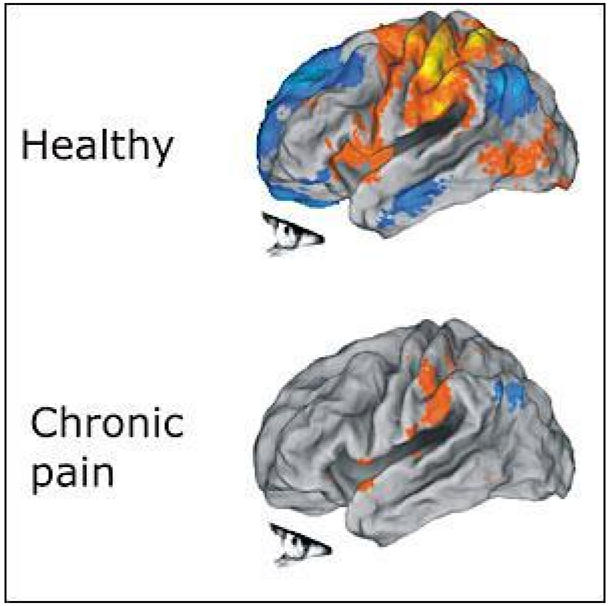
Pathways from Skin to Cortex





Modern imaging tools are now used to monitor brain activity when pain is experienced. One finding is that no single area in the brain generates pain; rather, emotional and sensory components together constitute a mosaic of activity leading to pain. Interestingly, when people are hypnotized so that a painful stimulus is not experienced as unpleasant, activity in only some areas of the brain is suppressed. The stimulus is still experienced, but it doesn’t hurt anymore. As such techniques for brain study improve, it should be possible to better monitor the changes in the brain that occur in people with persistent pain and to better evaluate the different painkilling drugs being developed.

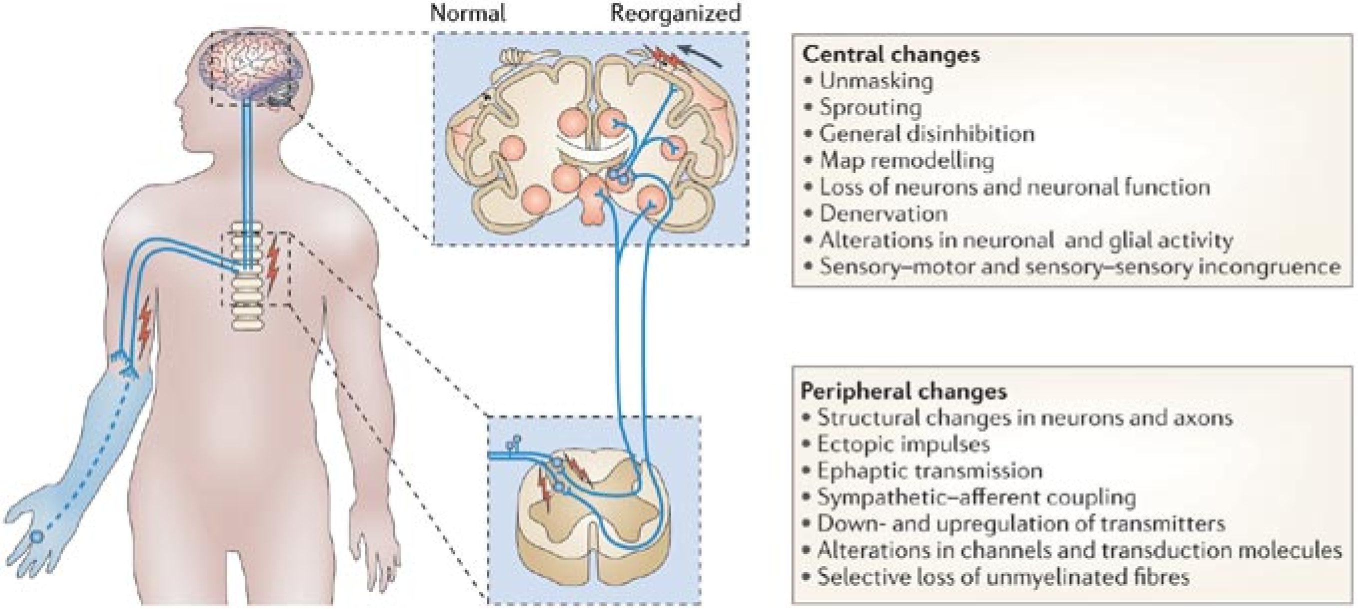
Chronic Pain Harms The Brain



Comparison of brains. These images show the brain from the left side, demonstrating striking differences between chronic pain patients and healthy subjects. They illustrate with colors how much activation (red-yellow) or deactivation (dark/light blue) was found at each location.

Researchers found that in a healthy brain all the regions exist in a state of equilibrium. When one region is active, the others quiet down. But in people with chronic pain, a front region of the cortex mostly associated with emotion "never shuts up," said Dante Chialvo, lead author and associate research professor of physiology at the Feinberg School. "The areas that are affected fail to deactivate when they should.“ They are stuck on full throttle, wearing out neurons and altering their connections to each other. Retrieved October 6, 2010, from http://www.sciencedaily.com /releases/2008/02/080205171755.htm

A schematic diagram of the areas involved in the generation of phantom limb pain and the main peripheral and central mechanisms.

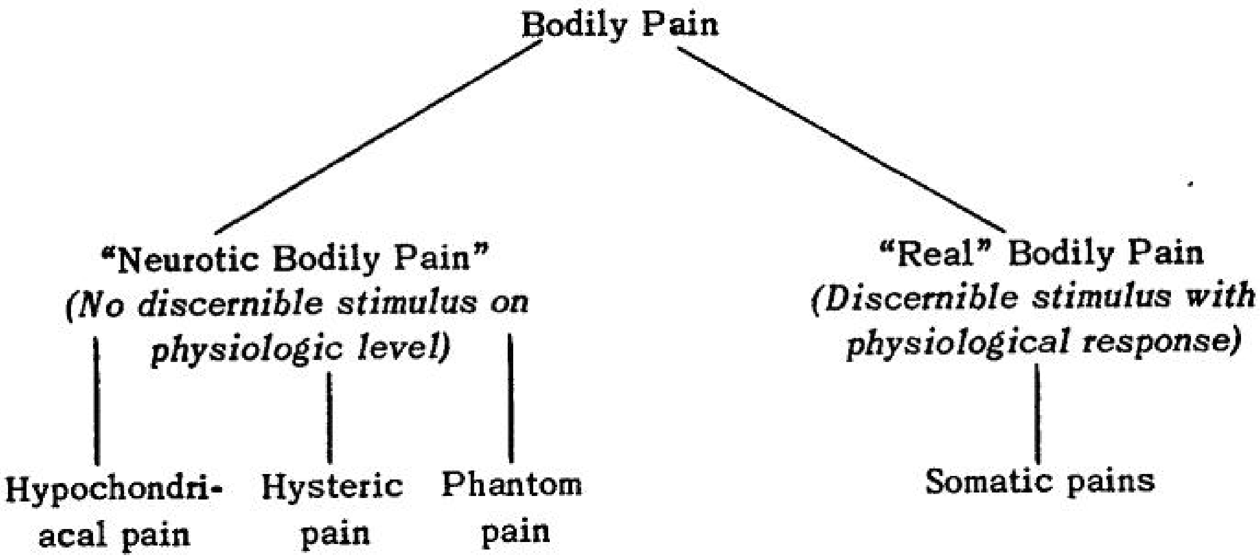


Nature Reviews | Neuroscience

The peripheral areas include the residual limb and the dorsal root ganglion, and the central areas include the spinal cord and supraspinal centres such as the brainstem, thalamus, cortex and limbic system. The proposed mechanisms associated with phantom pain are listed for the PNS and CNS. *Nature Reviews Neuroscience* 7, 873-881 (November 2006)

Phantom pain

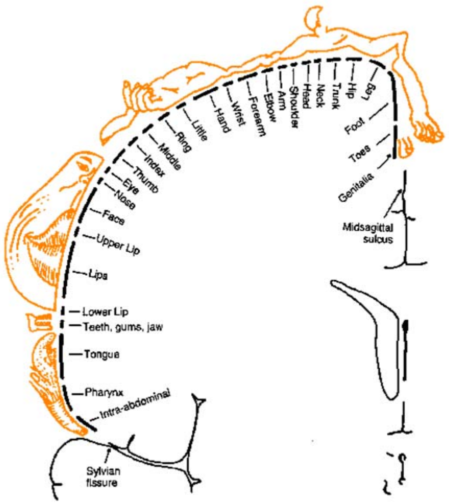
Phantom pain refers to pain in a body part that has been amputated or deafferented. It has often been viewed as a type of mental disorder or has been assumed to stem from pathological alterations in the region of the amputation stump. In the past decade, evidence has accumulated that phantom pain might be a phenomenon of the CNS that is related to plastic changes at several levels of the neuraxis and especially the cortex.

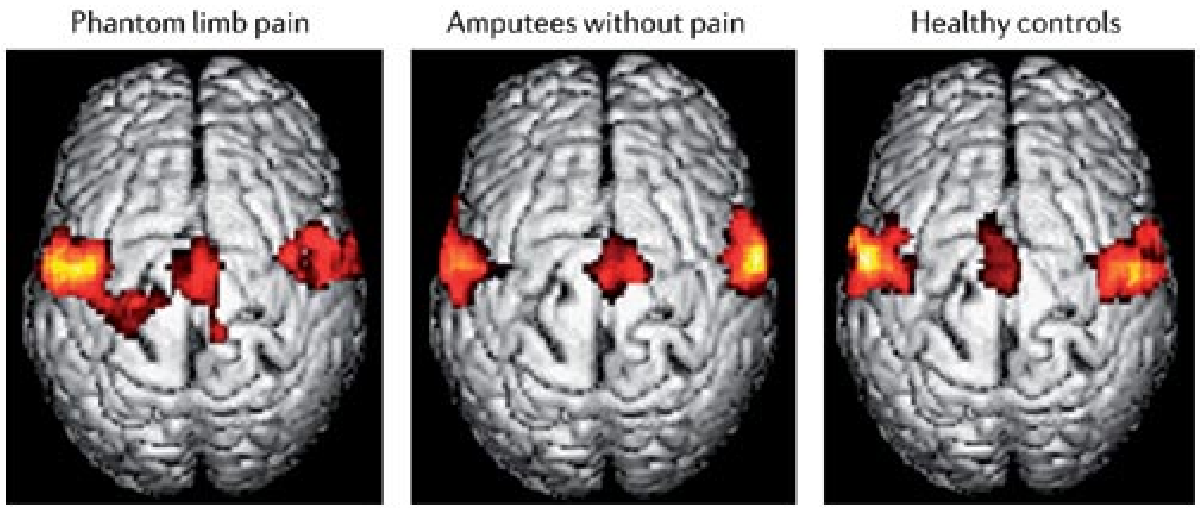


(1958). Psychoanalytic Study of the Child, 13:147-189

Referred phantom sensation

cortical reorganization in the primary somatosensory (SI) cortex
reorganizational shifts in the SI cortex





Functional MRI data from seven patients with phantom limb pain, seven amputees without pain and seven healthy controls during a lip pursing task. Activation in primary somatosensory and motor cortices is unaltered in amputees without pain and is similar to that of healthy controls. In the amputees with phantom limb pain the cortical representation of the mouth extends into the region of the hand and arm.