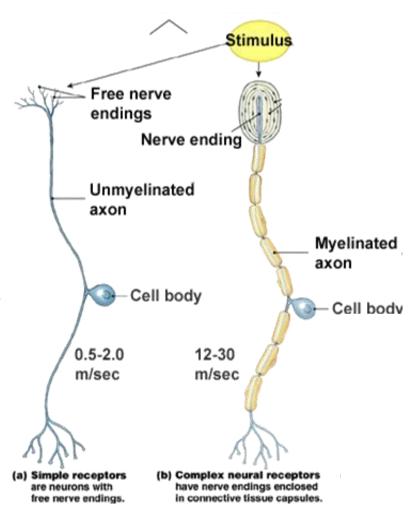
# Somatosensitivity, viscerosensitivity, proprioception and pain III

#### **Evolutionary point of view**

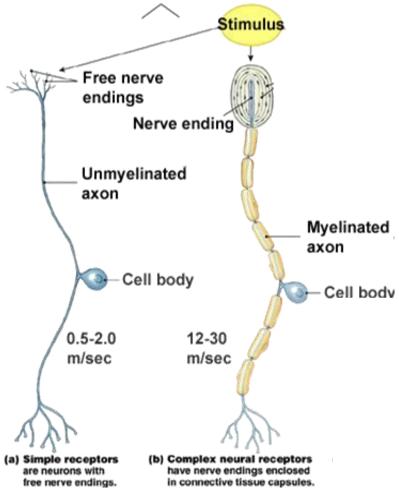
- The signals indicating potential damage are the most important and the corresponding systems evolved early
  - Pain
  - Temperature
- The touch signals have adaptive value and evolved later



#### **Evolutionary point of view**

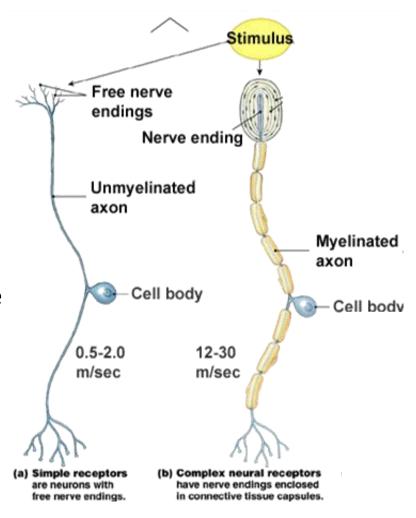
• The signals indicating potential damage are the mediate survival the correction evolved — Temperature

The term survival ve adaptive value



#### **Evolutionary point of view**

- The signals indicating potential damage are the most important and the corresponding systems evolved early
  - Pain
  - Temperature
- The touch signals have adaptive value and evolved later
- The structure of the receptor, nerve fibers and pathways reflects the evolution



- Three systems
- (Archispinothalamic)
  - Interconnection of adjacent segments (tr. Spinospinalis)
- Paleospinothalamic
  - tr. Spinoreticularis, tr. Spinotectalis...
- Neospinothalamic
  - tr. Spinothalamicus
- Dorsal column system
  - tr. Spinobulbaris

- Three systems
- (Archispinothalamic)

EVOLUTION ....

- Neospinothala Evolutionary old structures have

   tr. Spinoth - tr. Spinothala not been replaced by new old ha Dorsal column s during evolution, but the old has

  - tr. Spinobulba - tr. Spinobulbaris been kept and the new added

- Paleospinothalamic
  - Low resolution dull, diffuse pain ("slow pain")
- Neospinothalamic
  - High resolution sharp, localized pain ("fast pain"), temperature
  - Low resolution touch
- Dorsal column system
  - High resolution touch, proprioception

- Paleospinothalamic
- Immediate survival Low resolution – dull, diffuse pain ("slow p»
- Neospinothalamic
  - High resolution sharp, localized pain ("fast pain"), temperature
  - Low resolution touch
- Dorsal column system
  - High resolution touch, proprioception

Long-term survival

Table I
The Sensory Modalities Represented by the Somatosensory Systems

Modality	Sub Modality	Sub-Sub Modality	Somatosensory Pathway (Body)	Somatosensory Pathway (Face)
Pain	sharp cutting pain		Neospinothalamic	Spinal Trigeminal
	dull burning pain		Paleospinothalamic	
	deep aching pain		Archispinothalamic	
Temperature	warm/hot		Paleospinothalamic	
	cool/cold		Neospinothalamic	
Touch	itch/tickle & crude touch		Paleospinothalamic	
	discriminative touch	touch	Medial Lemniscal	Main Sensory Trigeminal
		pressure		
		flutter		
		vibration		
Proprioception	Position: Static Forces	muscle length		
		muscle tension		
		joint pressure		
	Movement: Dynamic Forces	muscle length		
		muscle tension		
		joint pressure		
		joint angle		

http://neuroscience.uth.tmc.edu/s2/chapter02.html

• Tr. Spinoreticularis, spinotectalis...

- Tr. Spinoreticularis, spinotectalis...
- Evolved before neocortex

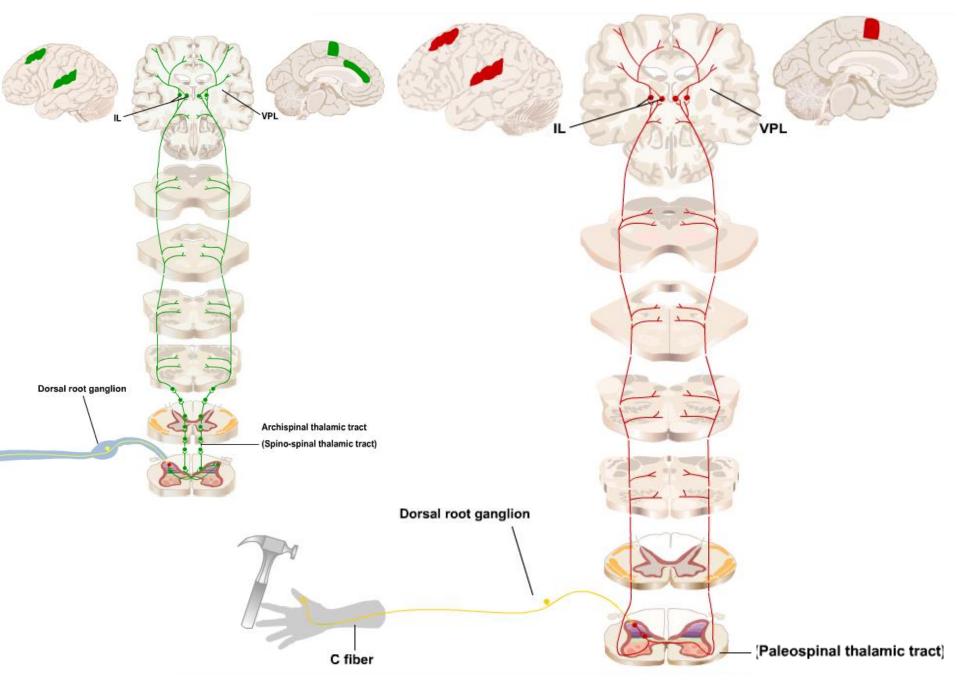
- Tr. Spinoreticularis, spinotectalis...
- Evolved before neocortex
- The primary connection to the subcortical structures

- Tr. Spinoreticularis, spinotectalis...
- Evolved before neocortex
- The primary connection to the subcortical structures
- Basic defensive reactions and reflexes vegetative response, reflex locomotion - opto-acoustic reflexes etc.

- Tr. Spinoreticularis, spinotectalis...
- Evolved before neocortex
- The primary connection to the subcortical structures
- Basic defensive reactions and reflexes vegetative response, reflex locomotion - opto-acoustic reflexes etc.
- Secondarily connected to cortex (after its evolution; tr. Spinoreticulo-thalamicus), but this system has a small resolutions dull diffuse pain

- Tr. Spinoreticularis, spinotectalis...
- Evolved before neocortex
- The primary connection to the subcortical structures
- Basic defensive reactions and reflexes vegetative response, reflex locomotion - opto-acoustic reflexes etc.
- Secondarily connected to cortex (after its evolution; tr. Spinoreticulo-thalamicus), but this system has a small resolutions dull diffuse pain
- This tract is not designed for "such a powerful processor as neocortex"

- Tr. Spinoreticularis, spinotectalis...
- Evolved before neocortex
- The primary connection to the subcortical structures
- Basic defensive reactions and reflexes vegetative response, reflex locomotion - opto-acoustic reflexes etc.
- Secondarily connected to cortex (after its evolution; tr. Spinoreticulo-thalamicus), but this system has a small resolutions dull diffuse pain
- This tract is not designed for "such a powerful processor as neocortex"
- Approximately half of the fibers cross the midline



http://neuroscience.uth.tmc.edu

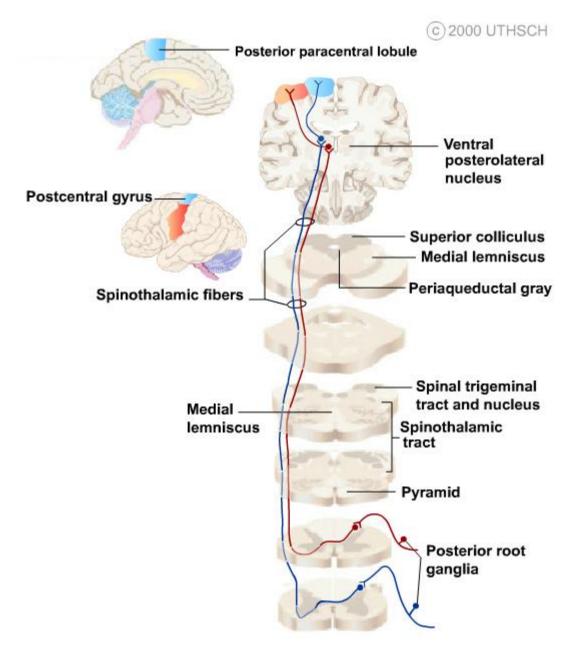
• Tr. Spinothalamicus

- Tr. Spinothalamicus
- Younger structure primarily connected to neocortex
- "High capacity/resolution"

- Tr. Spinothalamicus
- Younger structure primarily connected to neocortex
- "High capacity/resolution"
- Detail information about pain stimuli (sharp, localized pain)
- Information about temperature

- Tr. Spinothalamicus
- Younger structure primarily connected to neocortex
- "High capacity/resolution"
- Detail information about pain stimuli (sharp, localized pain)
- Information about temperature
- Crude touch sensation

- Tr. Spinothalamicus
- Younger structure primarily connected to neocortex
- "High capacity/resolution"
- Detail information about pain stimuli (sharp, localized pain)
- Information about temperature
- Crude touch sensation
- The fibers cross midline at the level of entry segment



http://neuroscience.uth.tmc.edu

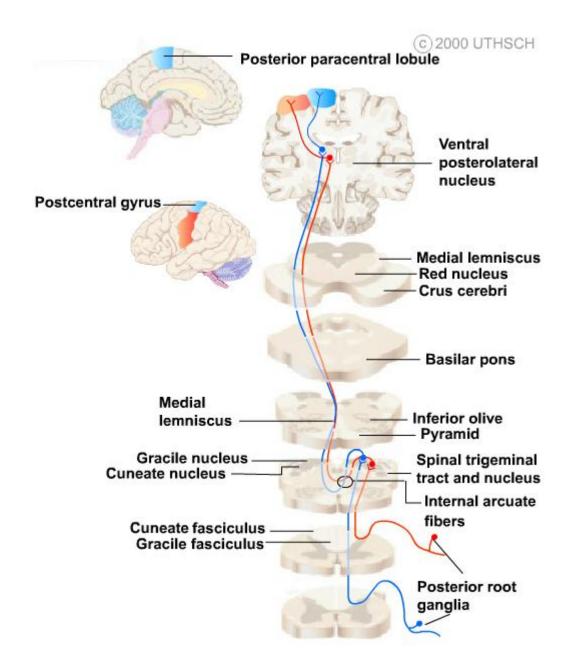
• Tr. Spinobulbaris

- Tr. Spinobulbaris
- The youngest system
- High capacity

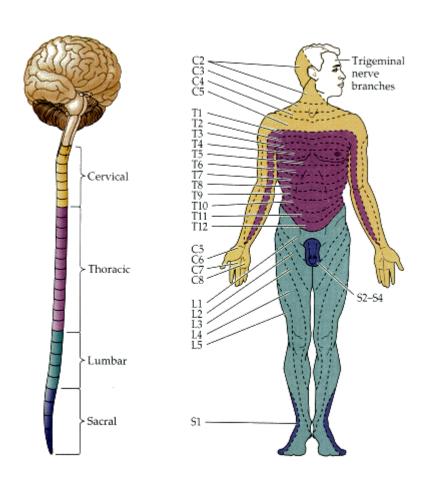
- Tr. Spinobulbaris
- The youngest system
- High capacity
- Tactile sensation
- Vibration
- Proprioception

- Tr. Spinobulbaris
- The youngest system
- High capacity
- Tactile sensation
- Vibration
- Proprioception
- Fine motor control
- Better object recognition
- Adaptive value

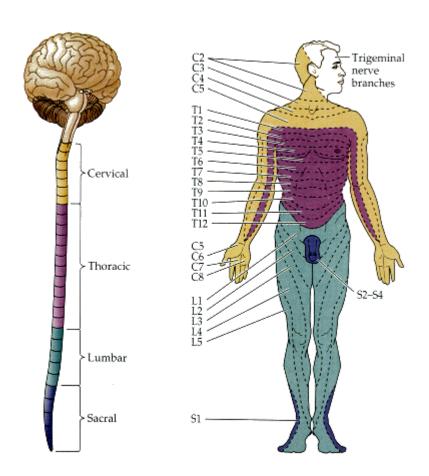
- Tr. Spinobulbaris
- The youngest system
- High capacity
- Tactile sensation
- Vibration
- Proprioception
- Fine motor control
- Better object recognition
- Adaptive value
- The fibers cross midline at the level of medulla oblongata

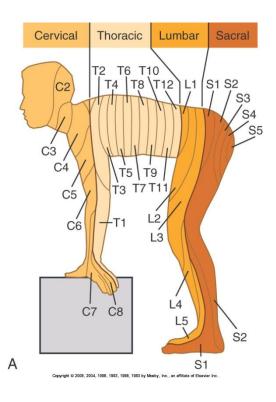


#### **Dermatoms**

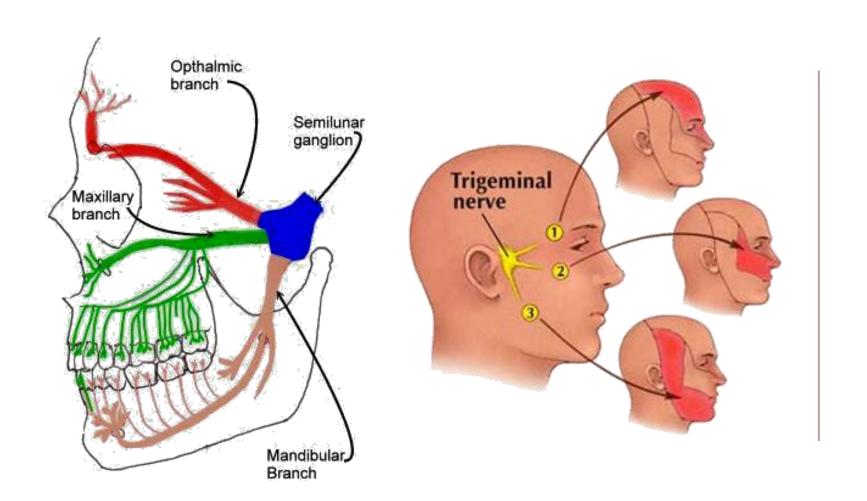


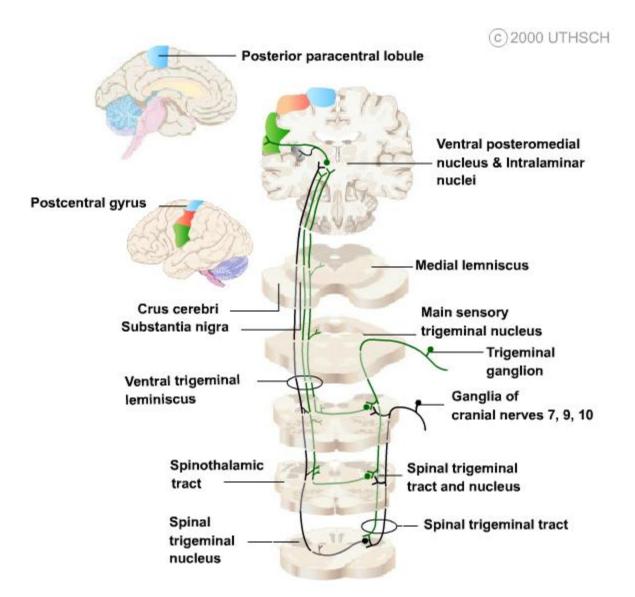
#### **Dermatoms**





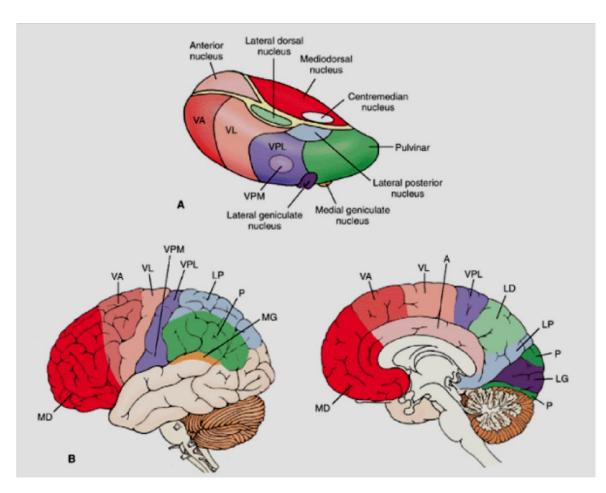
#### **Trigeminal system**



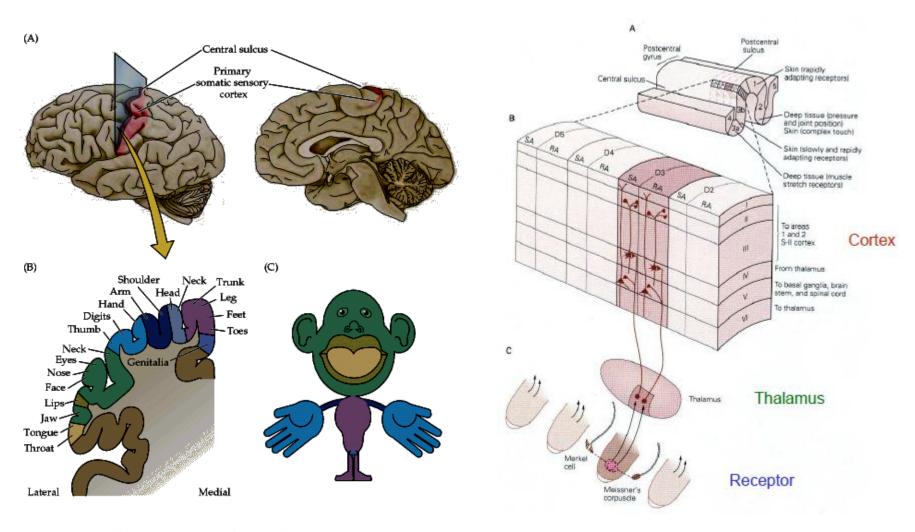


#### Thalamus a neocortex

- Almost all the afferent information gated in the thalamus
- Olfaction is an exception
- Bilateral connections between neocortex and thalamus



#### **Neocortex**

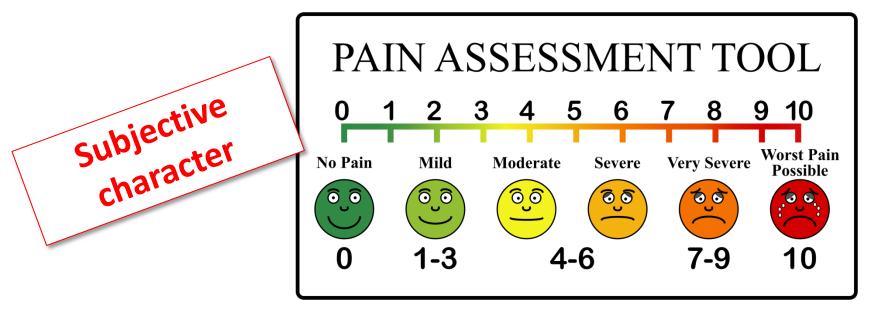


http://www.slideshare.net/drpsdeb/presentations

http://www.shadmehrlab.org/Courses/physfound\_files/wang\_5.pdf

#### **Pain**

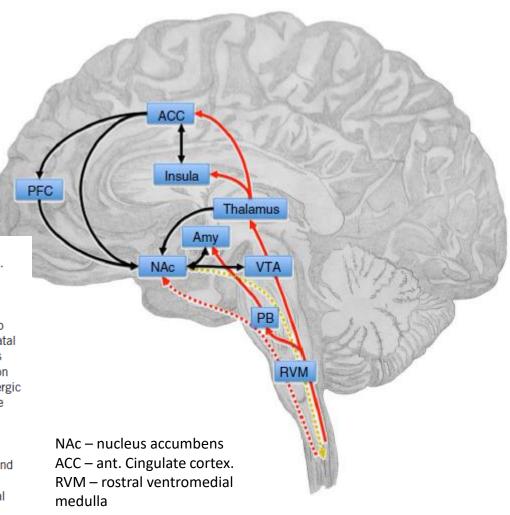
- Distressing feeling associated with real or potential tissue damage
- Sensor x psychological component
- Physiological x pathological pain
- Acute (up to 6months) x chronic (more than 6 months)



#### **Limbic system**

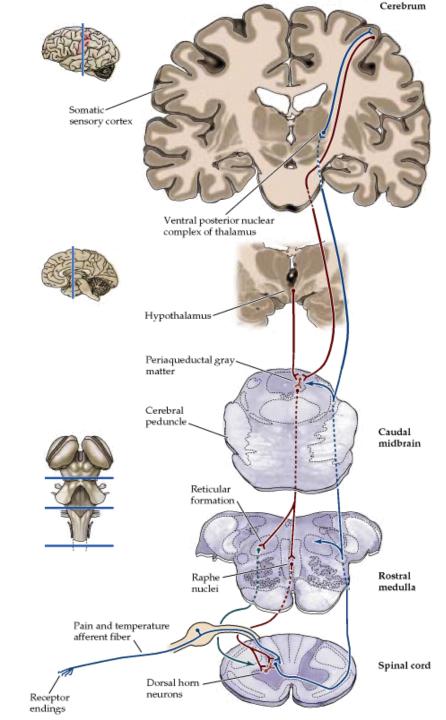
Navratilova E, Porreca F. Reward and motivation in pain and pain relief. *Nat Neurosci*. 2014;17:1304–1312.

Figure 1 The corticolimbic circuit integrates motivationally salient information, including pain, and makes decisions about action selection. The NAc receives afferent nociceptive information through connections with the thalamus, parabrachial area (PB), amygdala (Amy) and ACC. Direct projections from the spinal cord to the NAc may be postulated on the basis of findings in rodents<sup>47</sup> (red lines). VTA dopaminergic inputs to the NAc signal saliency, as well as the value of pain or relief. Corticostriatal connections from prefrontal, orbitofrontal and anterior cingulate cortices contribute to affective, emotional and cognitive control of pain perception and are involved in motivational decision-making. In the NAc, glutamatergic outputs from the amygdala converge on dopaminergic terminals from the VTA and influence motivated behavior in response to stress and anxiety (black lines). A descending pathway from the NAc that can modulate spinal nociceptive signals, possibly via the RVM, has been suggested 109 (gold dotted line). Chronic pain states are characterized by anatomical and functional reorganization of the corticolimbic circuit, including changes in gray matter density in the PFC, ACC and NAc and increased functional connectivity between the PFC and NAc108.



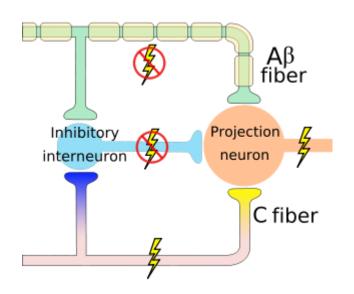
## Descendent pathways modulating pain

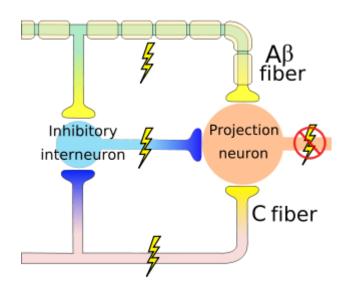
- Somatosemcoric cortex
- Hypotalamus
- Periaquaeductal gray
- Nuclei raphe



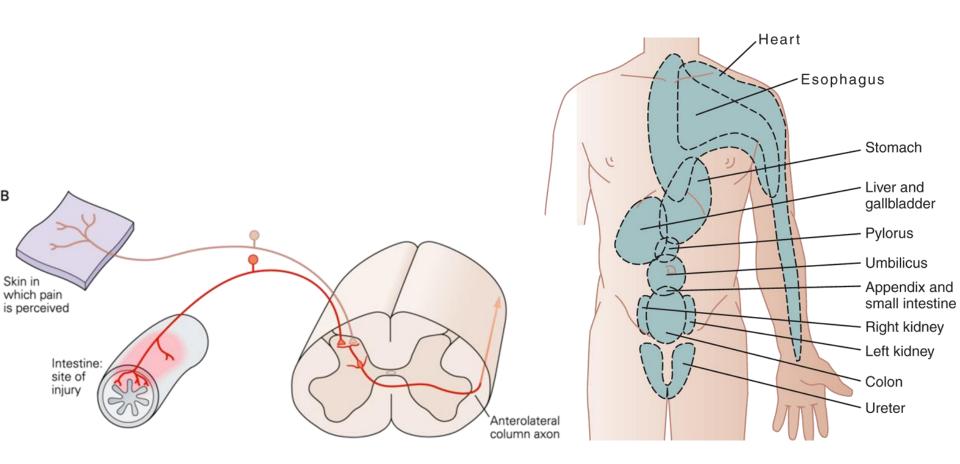
#### Pain modulation on the spinal level

#### Gate control theory of pain



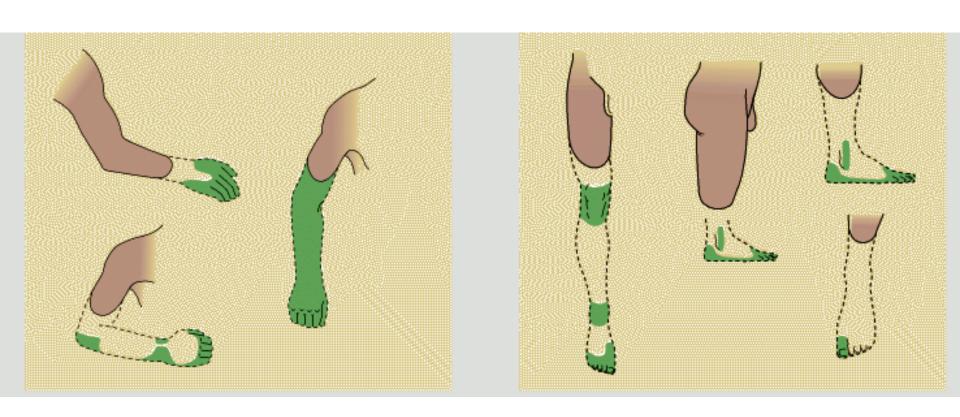


#### Referred pain



http://www.slideshare.net/drpsdeb/presentations

#### **Phantom limb pain**



http://www.slideshare.net/drpsdeb/presentations