Section 6

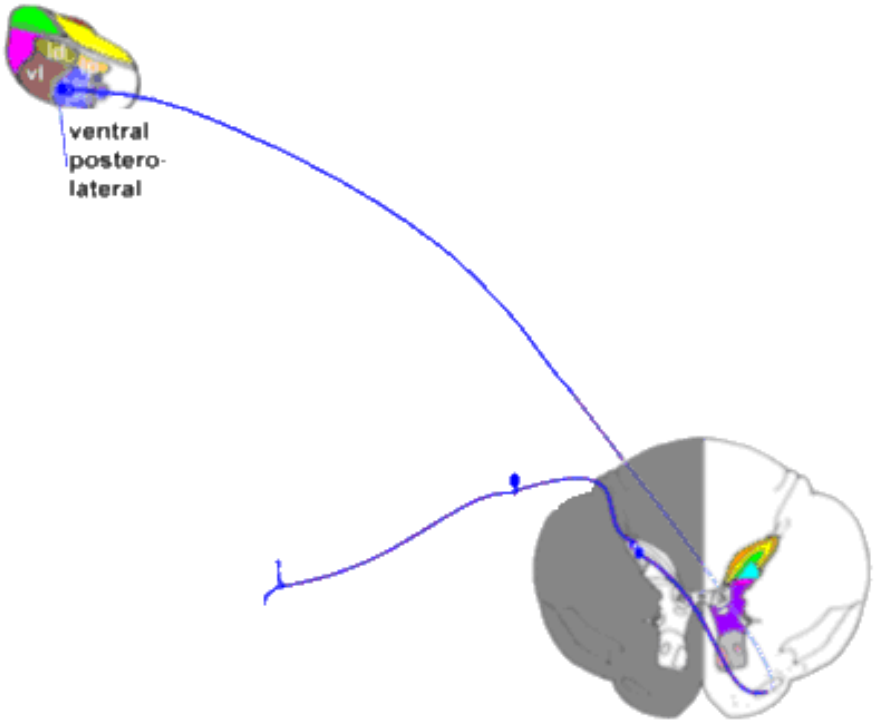
An Overview of How The Brain Nuclei Function Together

'Discriminative' fibers ascend from the spinal cord to the lateral thalamus and then to the primary sensory cortex(S I). These are called the neospinothalamic fibers.
'Affective' fibers that follow a similar course from the spinal cord, but end up in the reticular formation of the hindbrain. These spino-reticulodiencephalic fibers have extensive connections throughout the brainstem, and from there project to the medial thalamus and the cortex (S II).
Descending fibers pass down from the brainstem to the spinal cord inhibiting incoming sensations of pain. Many of these descending fibers originate in the locus coeruleus, others in the raphe nuclei.

The Spinal Cord

Traditionally it was thought that most pain fibers entered the dorsal root of the spinal cord (the "sensory" root) and then synapsed in the dorsal part of the spinal grey matter, before passing the message up through the spinothalamic tract. However, research suggests that up to 40% of sensory fibers enter in the ventral root.[1]

Histologically the grey matter of the spinal cord is divided into ten 'laminae'. The dorsal part is divided into five laminae (I to V), components of which deal with most incoming pain fibers. VII is in between these laminae and the more ventral laminae VIII and IX, and X refers to the grey matter around the central canal of the spinal cord. And what about lamina VI? This is only discernible in the bulges in the cord related to where the innervation of the limbs originates.



A transverse section through the thoracic spinal cord illustrating the grey matter and various laminae.
Important fibers coming from the periphery into the dorsal horn include:

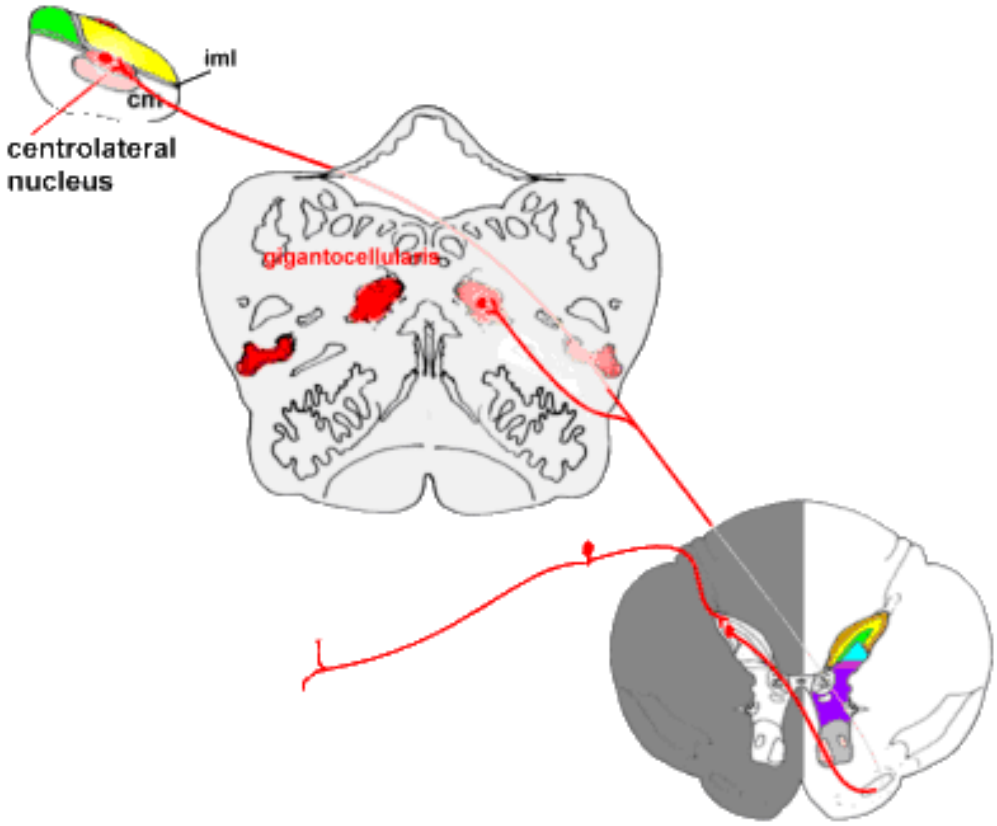
- Tiny unmyelinated 'C' fibers that are important carriers of long-lasting burning pain. These fibers terminate in lamina II.

- Thin myelinated 'A delta' fibers, concerned with more accurate localization of pain, and terminating mostly laterally in laminae I and V.
- Thick 'A beta' fibers that carry information about vibration and position sense from the periphery to the cord.

Unpleasant stimuli entering via the C fibers can be suppressed by concurrent stimulation of A delta fibers (high amplitude low frequency stimulation, for example by acupuncture) or by impulses passing through A beta fibers. Examples of the latter include TENS (transcutaneous electrical nerve stimulation) or by rubbing the skin.

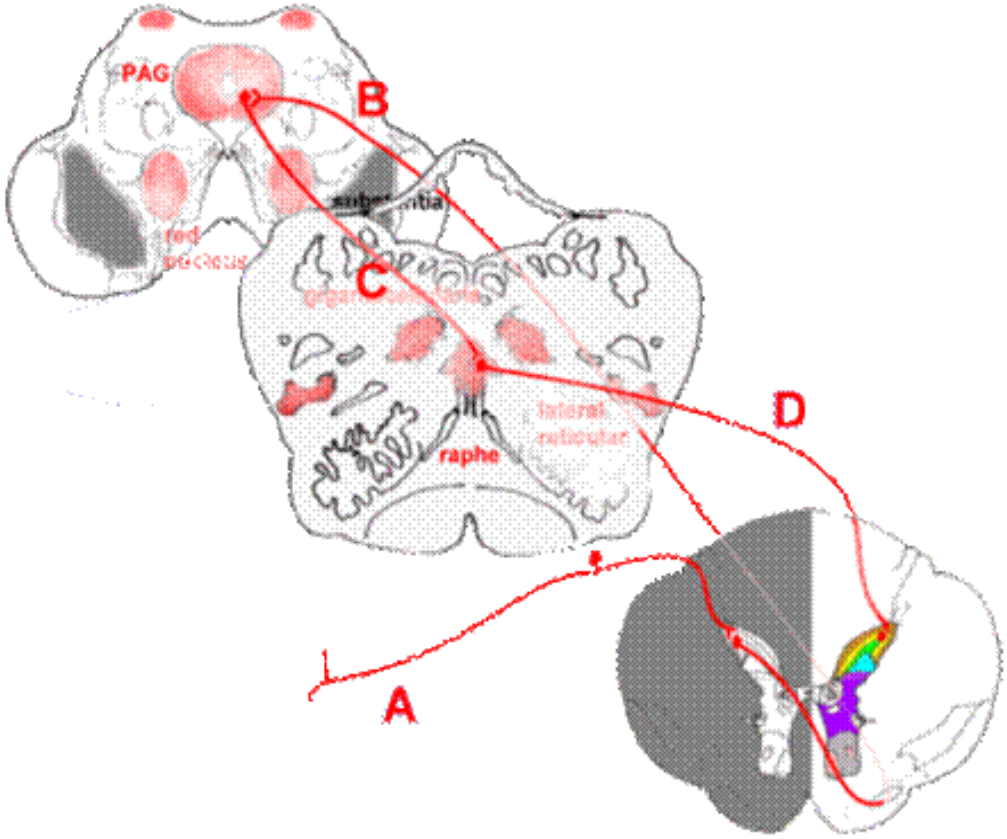
Ascending Pain Connections

Spino-reticulo-diencephalic connections:



Pathways from the spinal cord to the brainstem, and from there to the thalamus (diencephalon).
Some fibers pass directly to the medial thalamus, while others end in (or send collaterals to) a variety of nuclei in the brainstem.

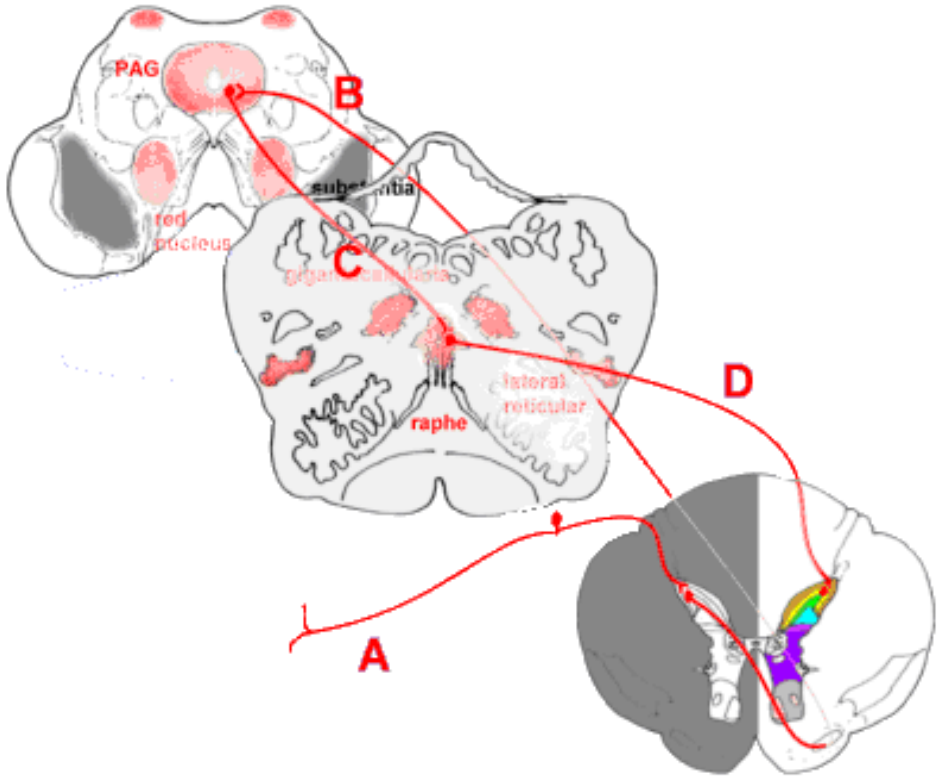
Pathways from cord to lateral thalamus and then on to the primary sensory cortex(SI) are discriminative pain pathways, and have little to do with perception of pain as a 'sore' stimulus. These pathways have few or no opioid receptors. Consequently, the use of morphine medication therapy would have no effect on such pathways.



The neospinothalamic tract.

Descending Pain Connections

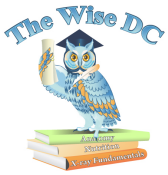
Fibers that descend from the brainstem to the spinal cord act to modulate incoming pain signals. Notable neurotransmitters mediating this anti-nociceptive effect include noradrenaline (norepinephrine), especially in the locus coeruleus, and serotonin in the raphe nuclei. Opioid receptors are abundant in the descending pain connection. Some descending connections are:



Descending connections that modulate incoming pain impulses.

Incoming pain stimuli are transmitted (A) to the dorsal horn, and from there (B) to the periaqueductal grey (PAG). Descending impulses pass (C) to the raphe nuclei, especially the nucleus raphe magnus, in the upper medulla, and thence back to the dorsal horn via reticulospinal fibers (D).

The above shows only the serotonergic descending fibers. Other pain-suppressing impulses pass from the PAG to the locus coeruleus, and from there to the dorsal horn.[2]



[1] www.anaesthetist.com/icu/pain
[2] www.anaesthetist.com/icu/pain