

Introduction to Medical Psychology

Lecture 9: Chronic Pain

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<https://youtu.be/yyCSYHy0JxM>

Lecture video at above link.

Today: Chronic Pain

- Basics of pain perception (Nociception)
- Top-down control of pain perception
- Chronic low back pain
- Treatment strategies for chronic low back pain

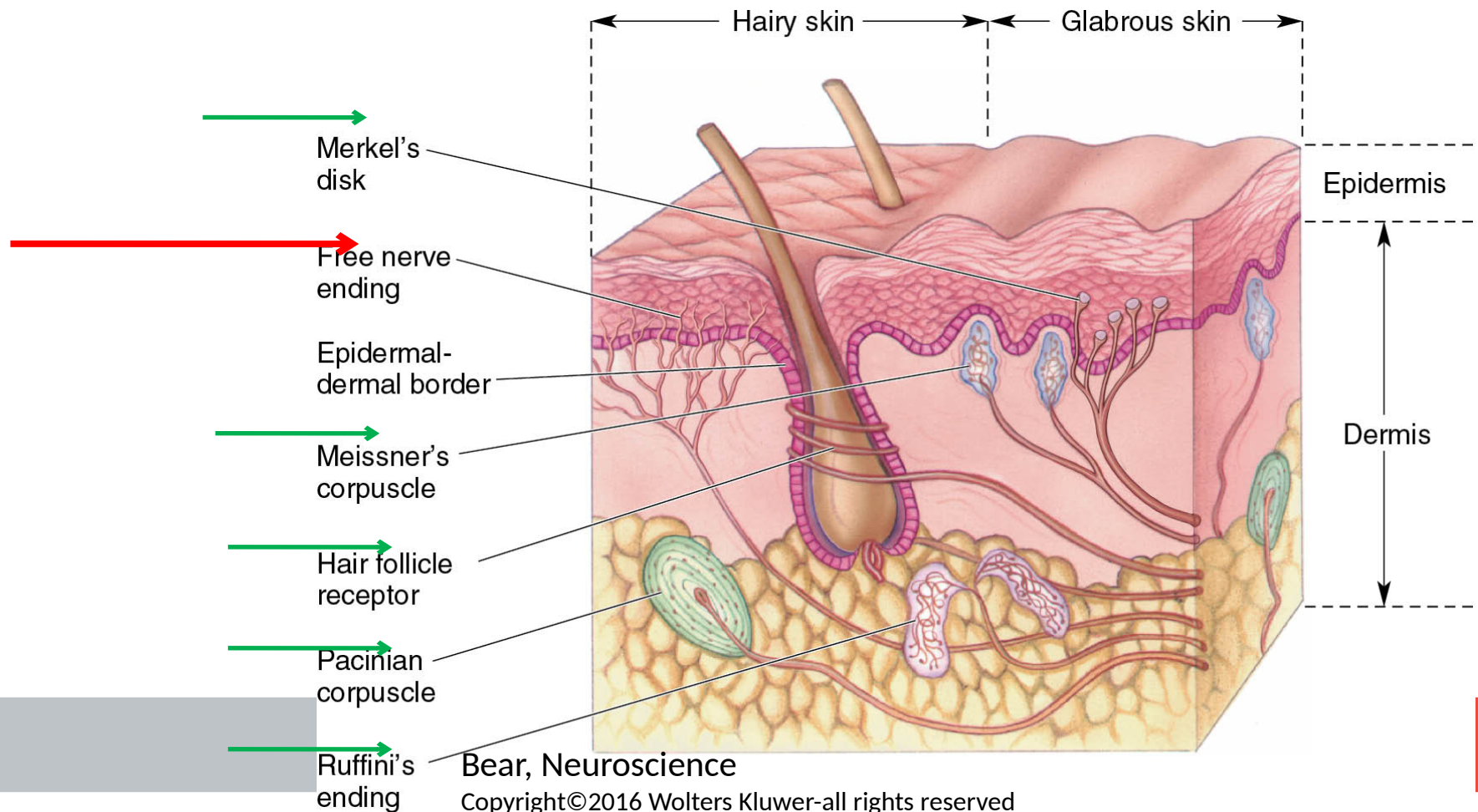


How does pain work?

Mechanoreceptors

Various receptor types are responsible for the perception of touch (marked with green arrow).

Free nerve endings in skin and internal organs respond to tissue damage, causing pain.

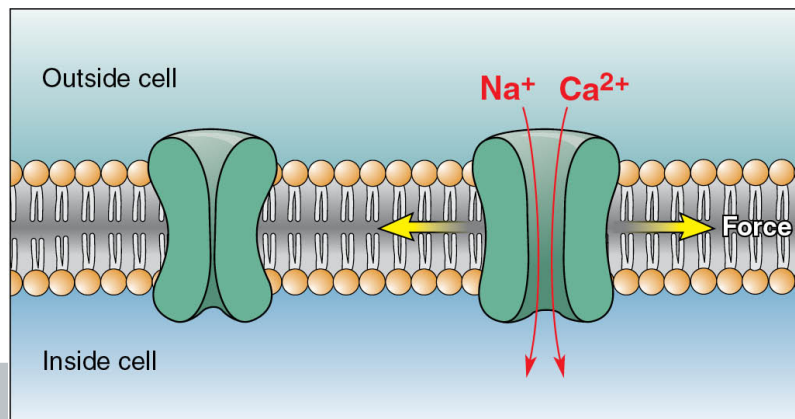


Nociceptors (neurons detecting painful stimulation)

Nociceptors located in skin, visceral organs, tendons, etc. can be grouped into four classes:

- Thermal (responds to temperatures > 43 deg Celsius or < 17 deg Celsius)
- Mechanical (responds to intense mechanical stimulation)
- Polymodal (responds to thermal, mechanical, or chemical stimulation)
- Silent nociceptor (responds to inflammation in visceral organs)

Nociception is mediated by activating membrane channels that open when stimulated (with a thermal, mechanical or other stimulus). When opening they let positively charged Na^+ or Ca^{2+} ions into the neuron, triggering an action potential.

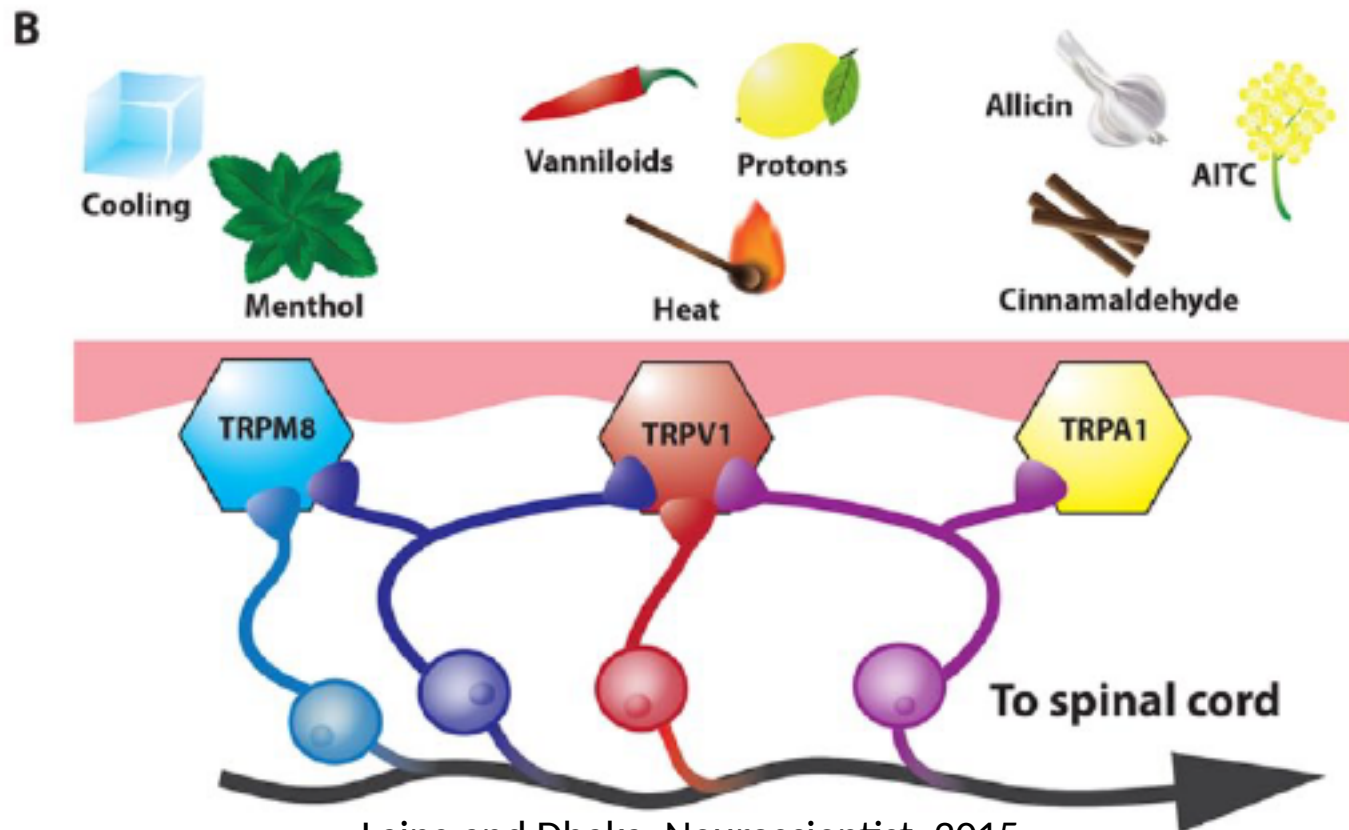


Bear, Neuroscience

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Nociceptive membrane channels

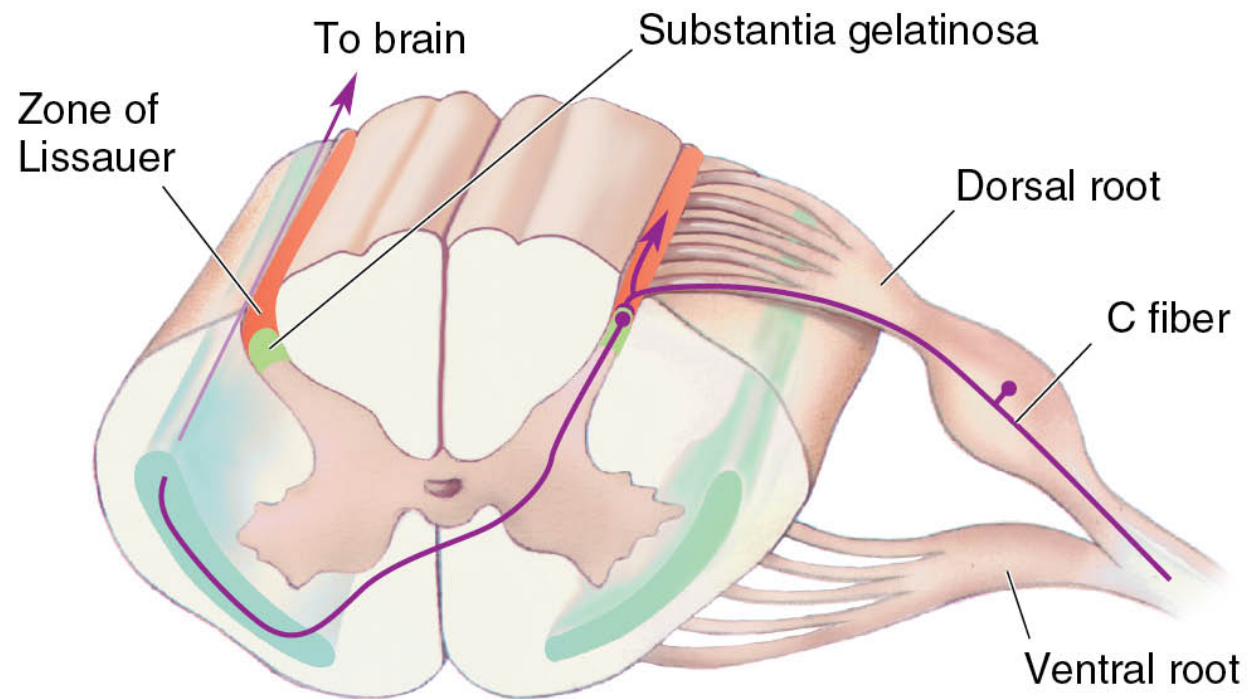
Several different membrane proteins are responsive to different types of stimulation. E.g., the TRPV1 (transient receptor potential cation channel V1) channel responds to heat (> 43 degree Celsius), acid (protons), and capsaicin (a vanilloid found in chili plants). TRPA1 is activated amongst other substances by AITC (mustard/wasabi) and cold temperature (< 17 degree Celsius).



Laing and Dhaka, Neuroscientist, 2015

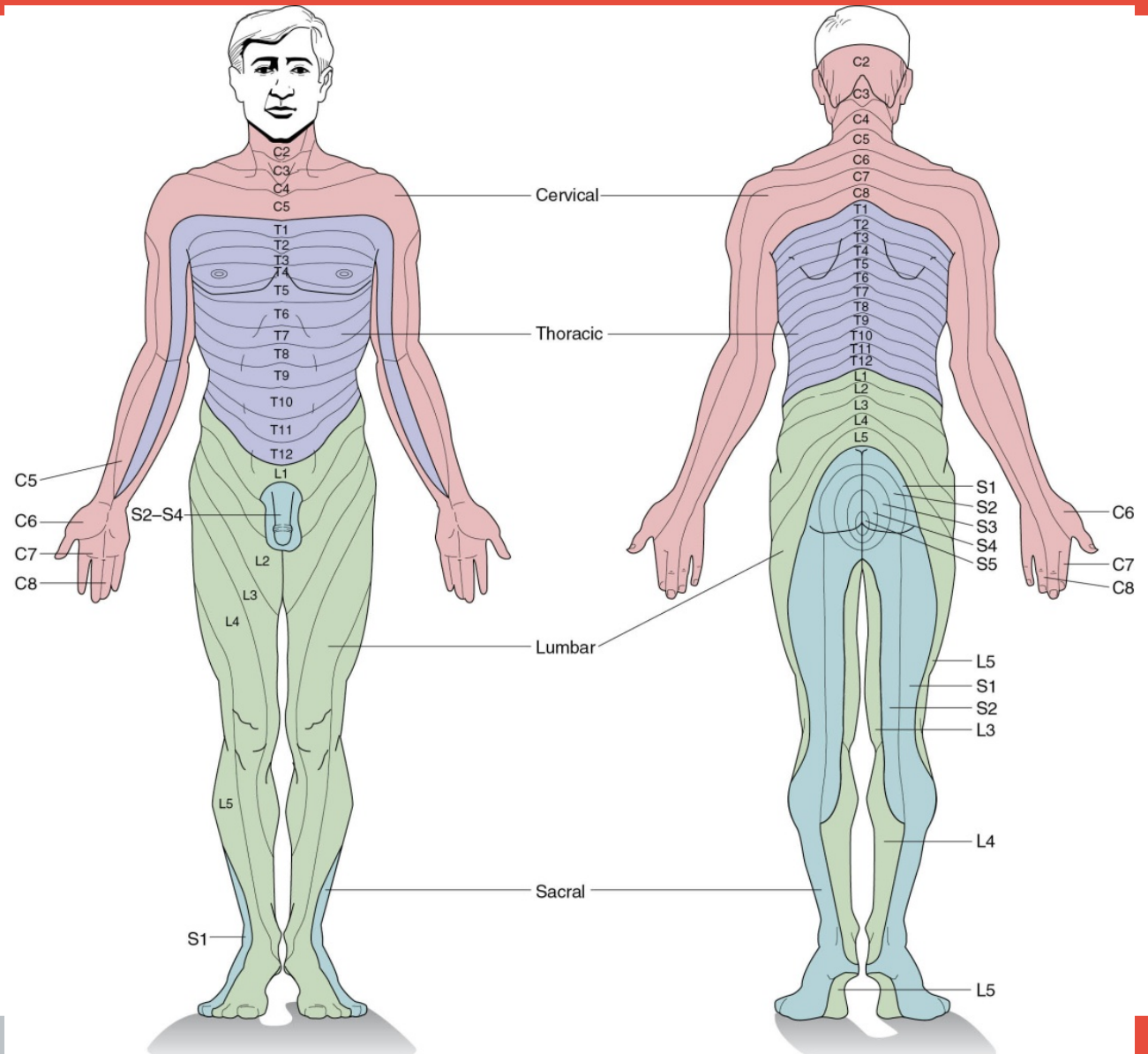
Nociceptor pathway

Nociceptors have their cell bodies in the dorsal root ganglia (see cross section of spinal cord below). They enter the spinal cord through the dorsal root and connect to neurons within the substantia gelatinosa.



Dermatomes

Somatosensory and pain nerves enter the spinal cord grouped along so-called dermatomes.

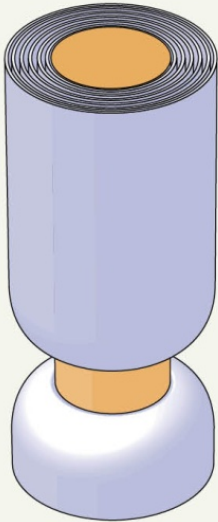


Pain Transduction

The pain pathway uses two types of nerve fibers:

- fast A δ fibers
- slower C fibers

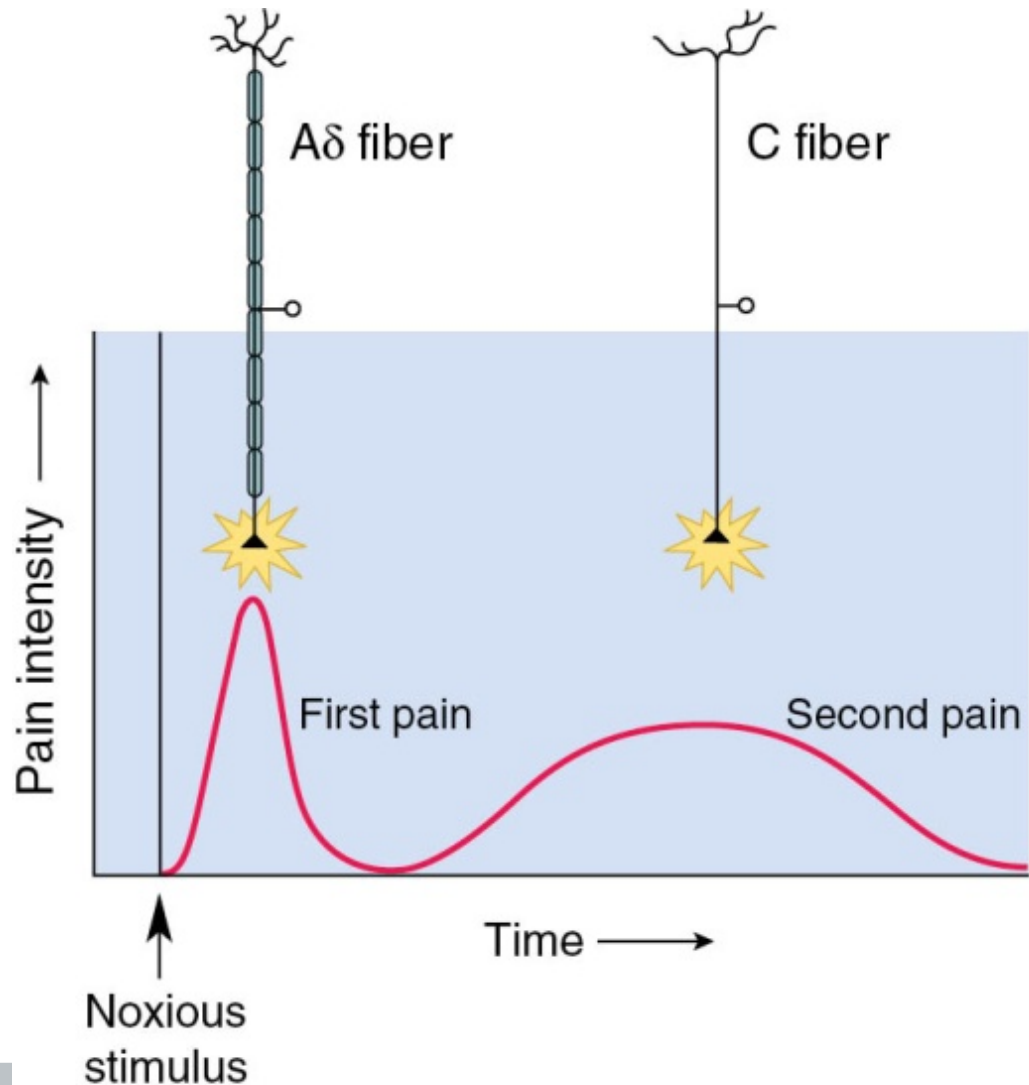
Speed depends on the diameter of the nerve fiber and its coating with myelin (electrical insulation).

Axons from skin	A α	A β	A δ	C
Axons from muscles	Group I	II	III	IV
				
Diameter (μm)	13–20	6–12	1–5	0.2–1.5
Speed (m/sec)	80–120	35–75	5–30	0.5–2
Sensory receptors	Proprioceptors of skeletal muscle	Mechanoreceptors of skin	Pain, temperature	Temperature, pain, itch

Pain transduction

These differences in transmission speed lead to two pain stages:

- 1) A fast “first pain” phase mediated by A δ fibers.
- 2) A slower, longer lasting “second pain” phase mediated by C fibers.



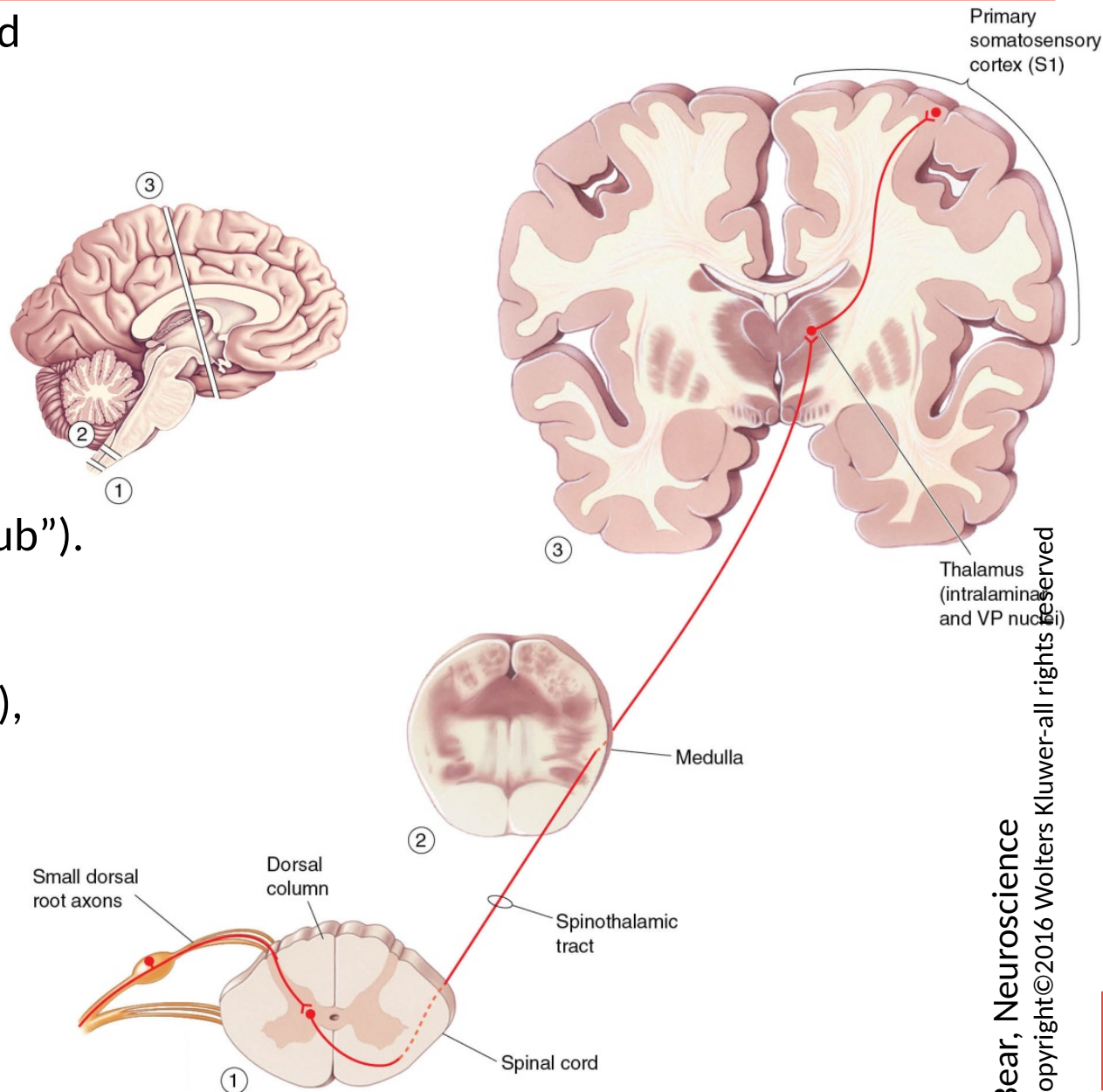
Pain pathway

Nociceptors synapse with spinal cord neurons (1).

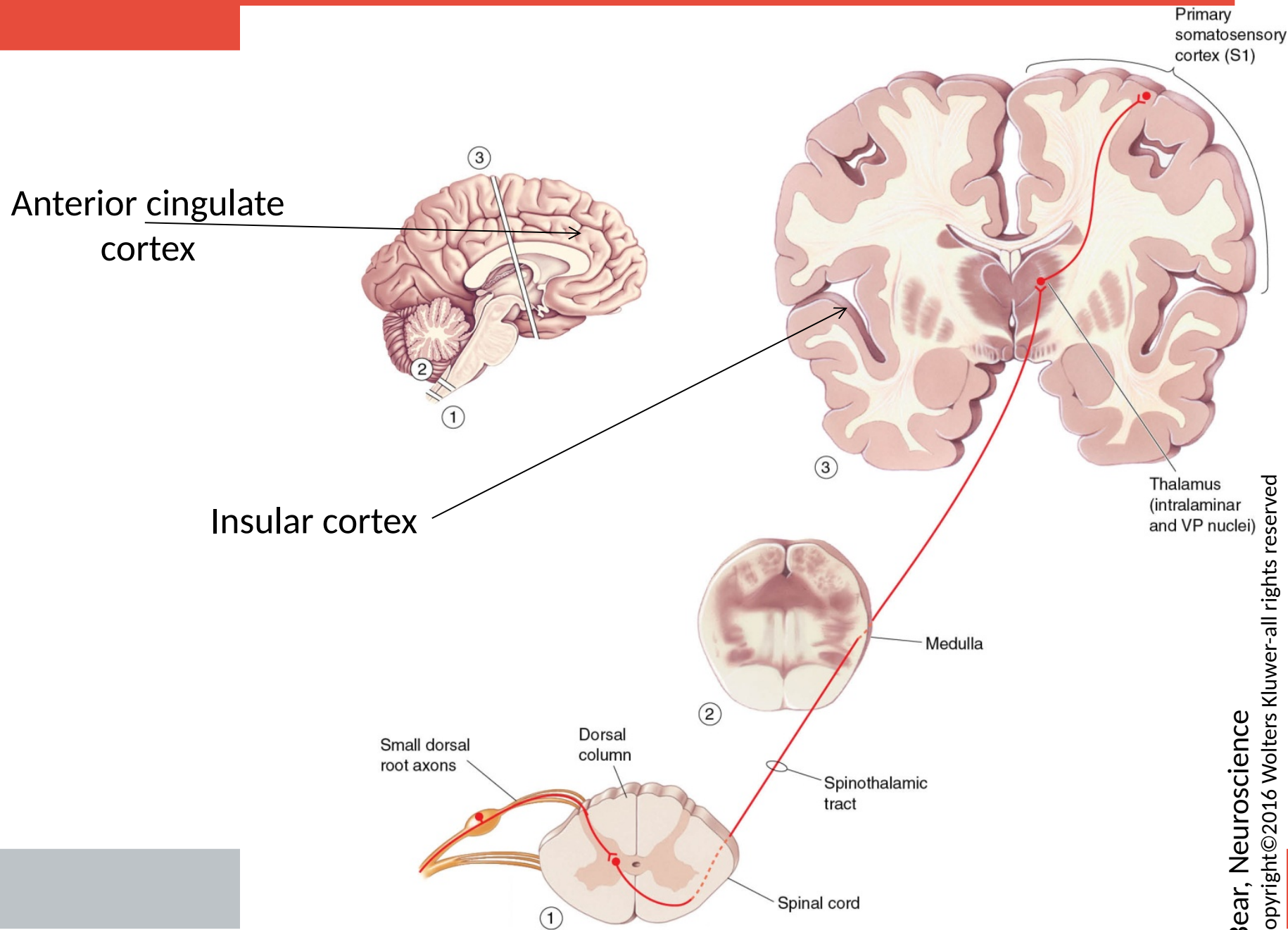
The nerve fibers cross the body midline at the level of the spinal cord segment.

The **spinothalamic tract** consist of fibers (2) from the spinal cord to thalamus (“sensory hub”).

Neurons from thalamus project to somato-sensory cortex (3), insular and cingulate cortex.



Insula and Cingulate cortex

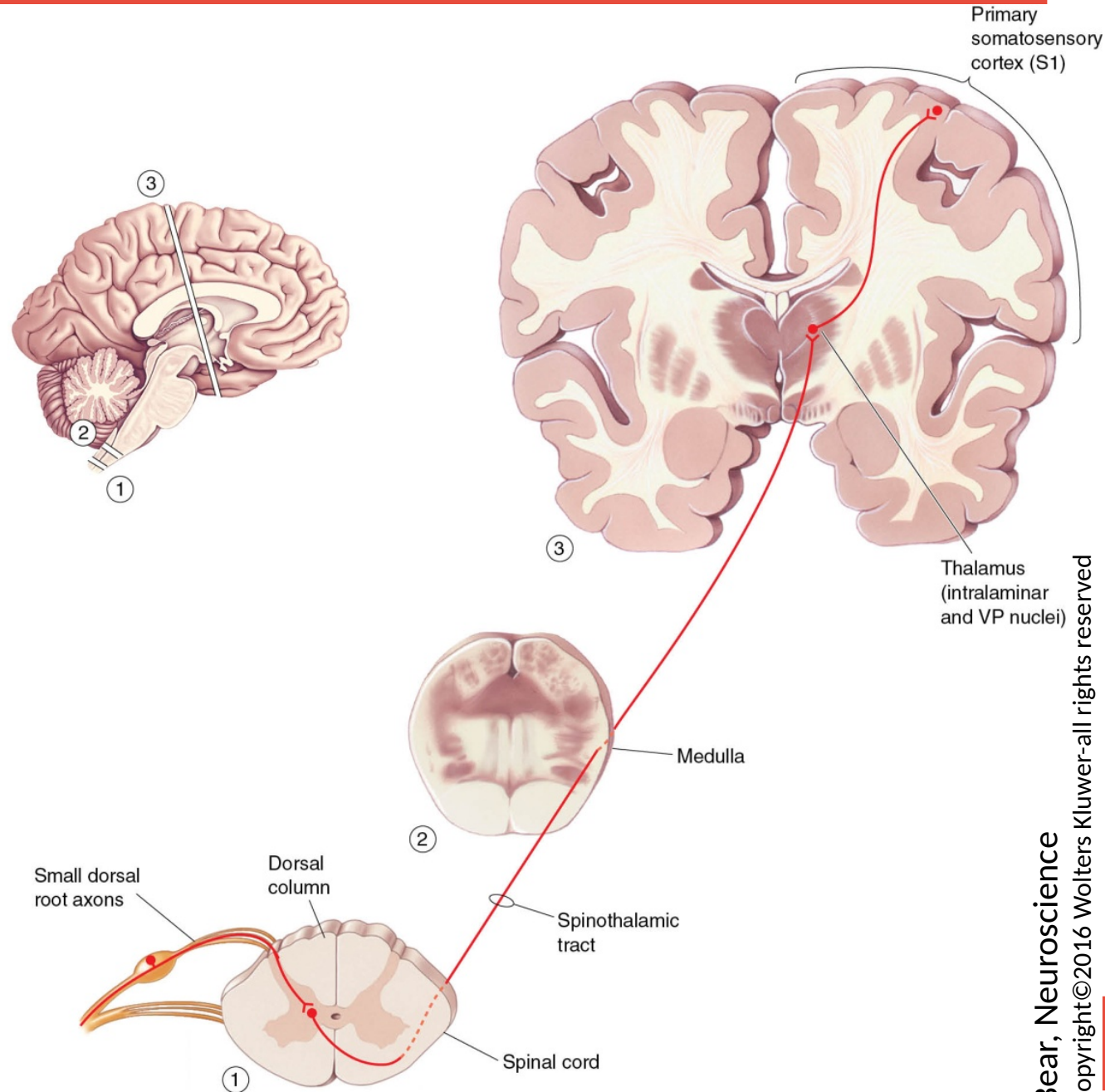


Hyperalgesia after pain

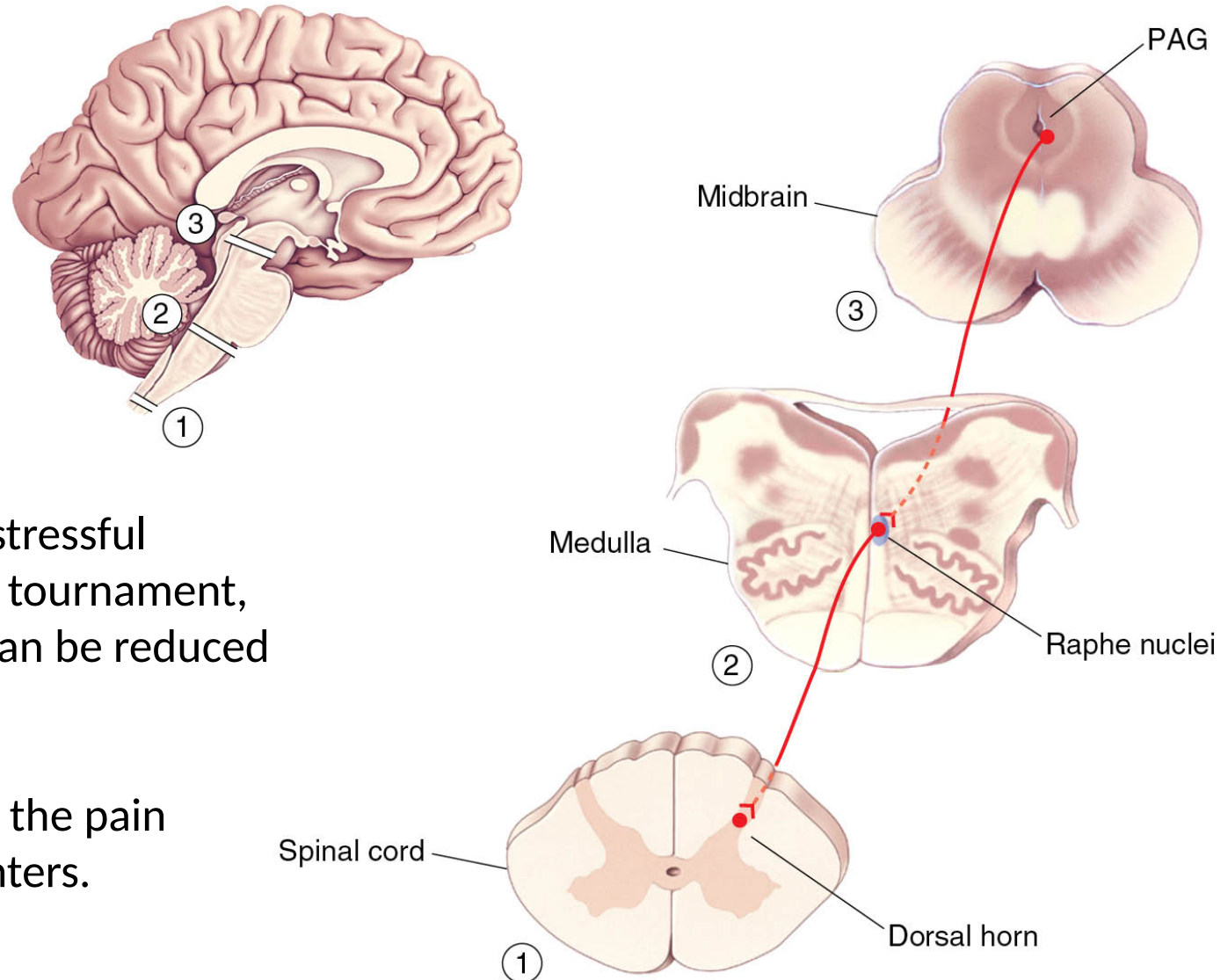
Intense pain can lead to changes in the sensitivity of synapses (long-term potentiation).

These implicit pain memory traces can lead to increased pain sensitivity and chronic pain.

Treating the acute pain with analgesic drugs might help to prevent this hyperalgesia effect.



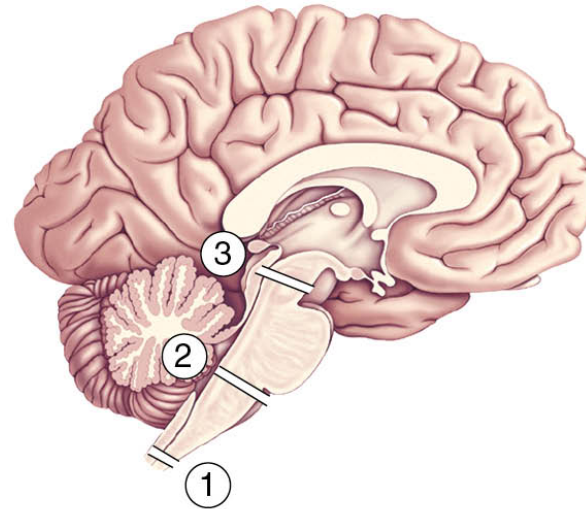
Top-down control of pain



In highly emotional or stressful situations (fight, sports tournament, etc.), pain perception can be reduced (analgesia).

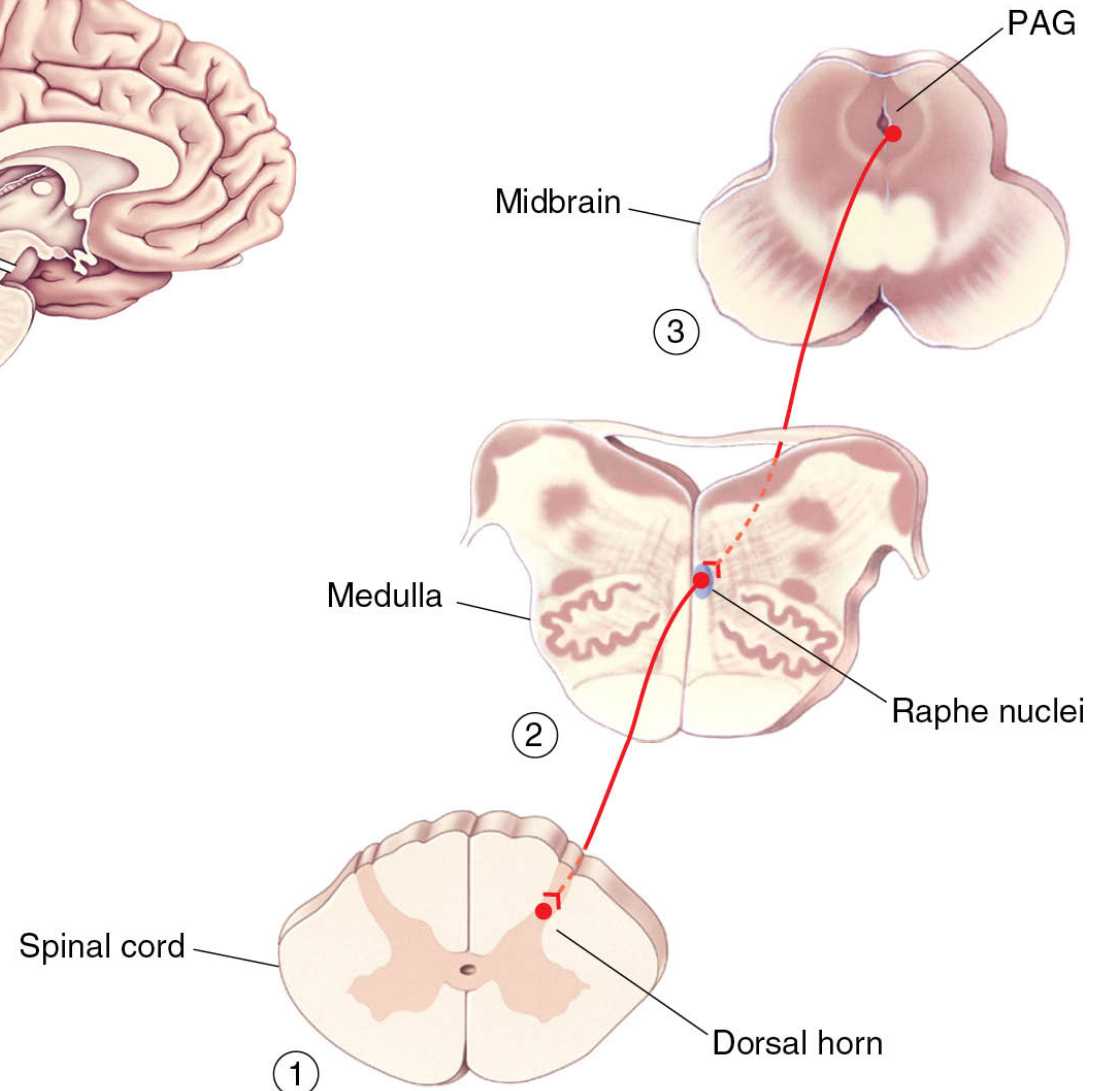
This requires control of the pain pathway by cortical centers.

Top-down control of pain

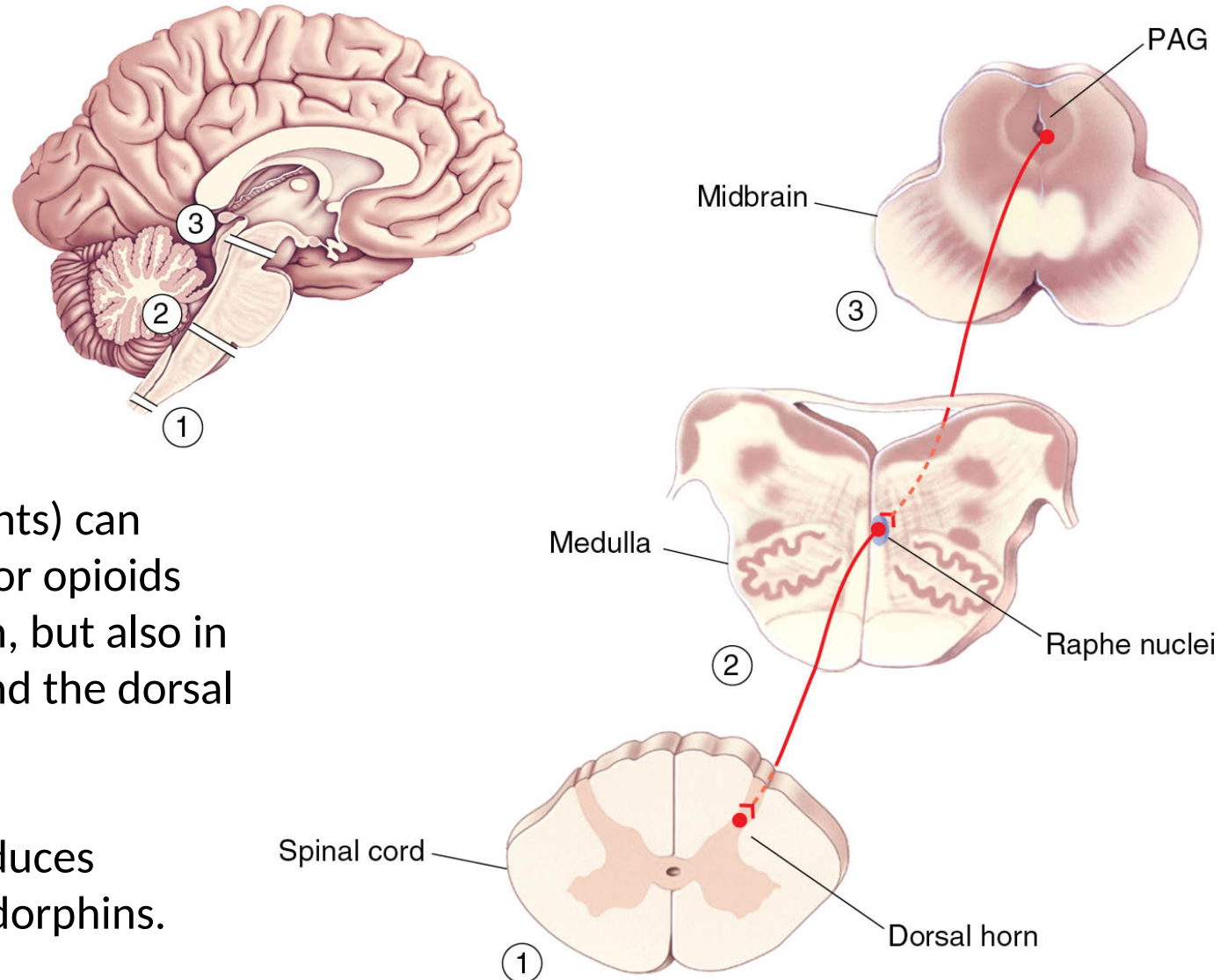


The PAG (periaqueductal gray) in midbrain and the Raphe nuclei are relay stations of cortical control of pain and can modulate pain-related neural activity in the spinal cord.

Electrical stimulation of these structures can reduce pain perception.



Top-down control of pain



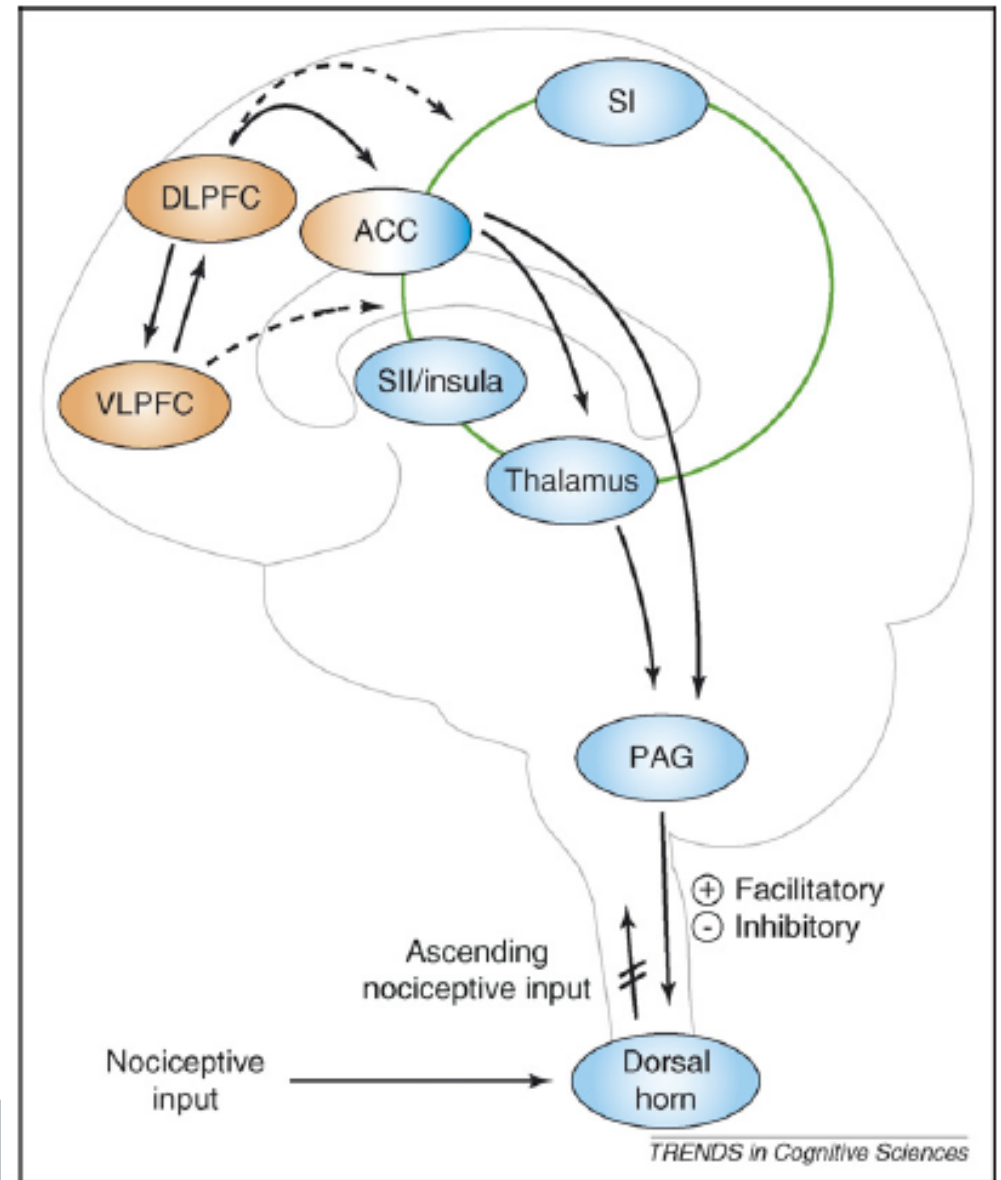
Opioids (from poppy plants) can reduce pain. Receptors for opioids can be found in the brain, but also in PAG, the Raphe nuclei and the dorsal horn of the spinal cord.

The nervous system produces endogenous opioids: endorphins.

Effect of attention on pain

Somatosensory cortex (SI, SII), anterior cingulate cortex (ACC), and insula are modulated by prefrontal areas (DLPFC: dorsolateral prefrontal cortex, VLPFC: ventrolateral prefrontal cortex), and in turn modulate ascending pain perception.

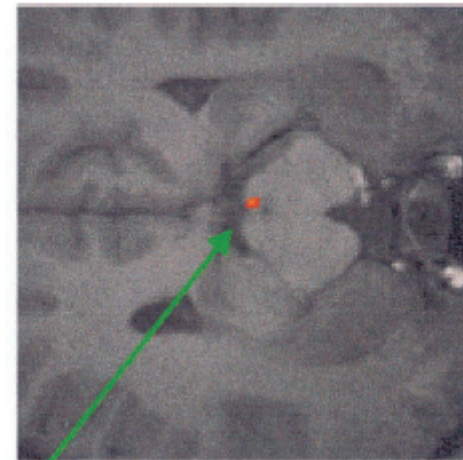
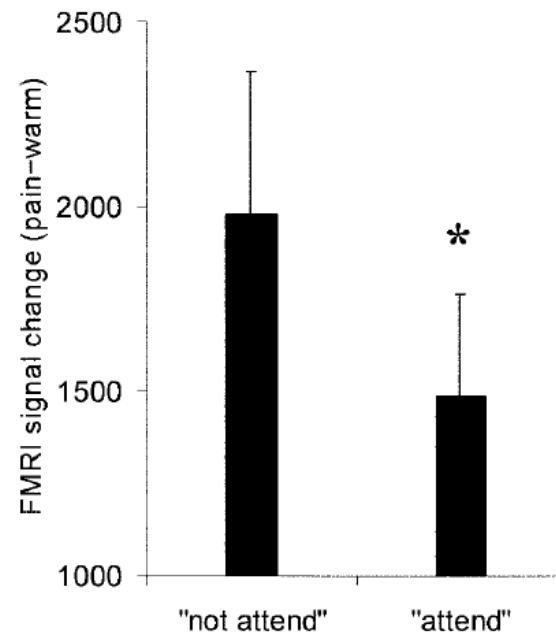
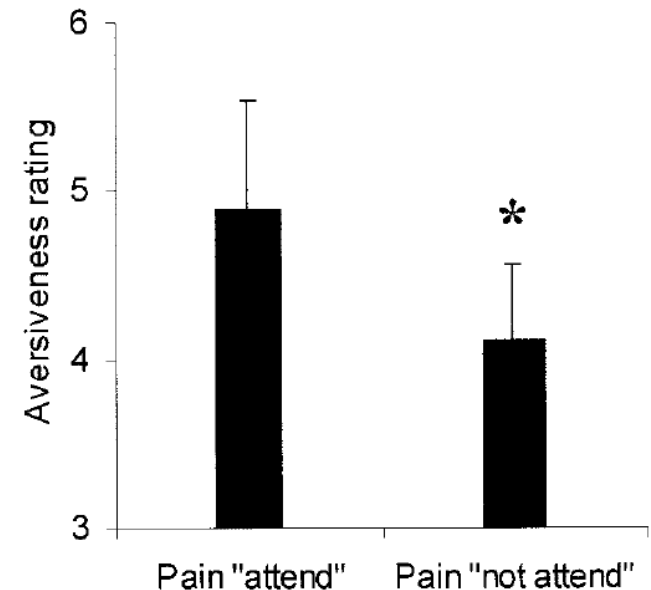
Attentional effects on pain perception (less pain when distracted) are assumed to be mediated by this network.



Effect of attention on pain

In this fMRI (functional magnetic resonance) study, 9 subjects either attended or did not attend ('think of s.th. else) a painful stimulus (hot plate).

Aversiveness of stimuli was decreased when pain was unattended. Brain activity in the PAG was higher when the pain was not attended, indicating top-down suppression of pain.



Lower back pain



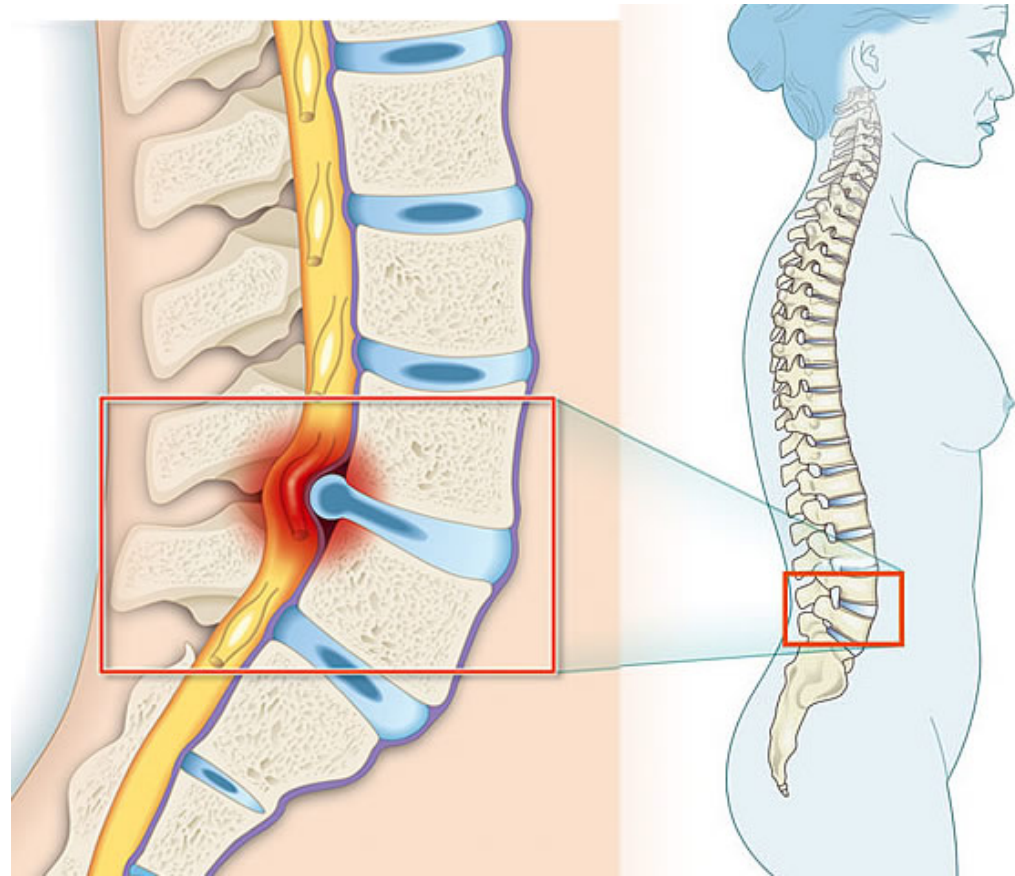
Acute low back pain is very common, about 1/3 of the adult population is affected at least once a year. This can last a few days or weeks. 80% of population (US or Germany) will suffer from low back pain at least once in their lives.

If low back pain persists for longer than 3 months, we speak of chronic low back pain.

Chronic lower back pain

Causes for acute lower back pain / lumbago can be various, for example:

- inflammations
- vertebral disk hernia; this may lead to pressure on nerves, in particular the sciatic nerve

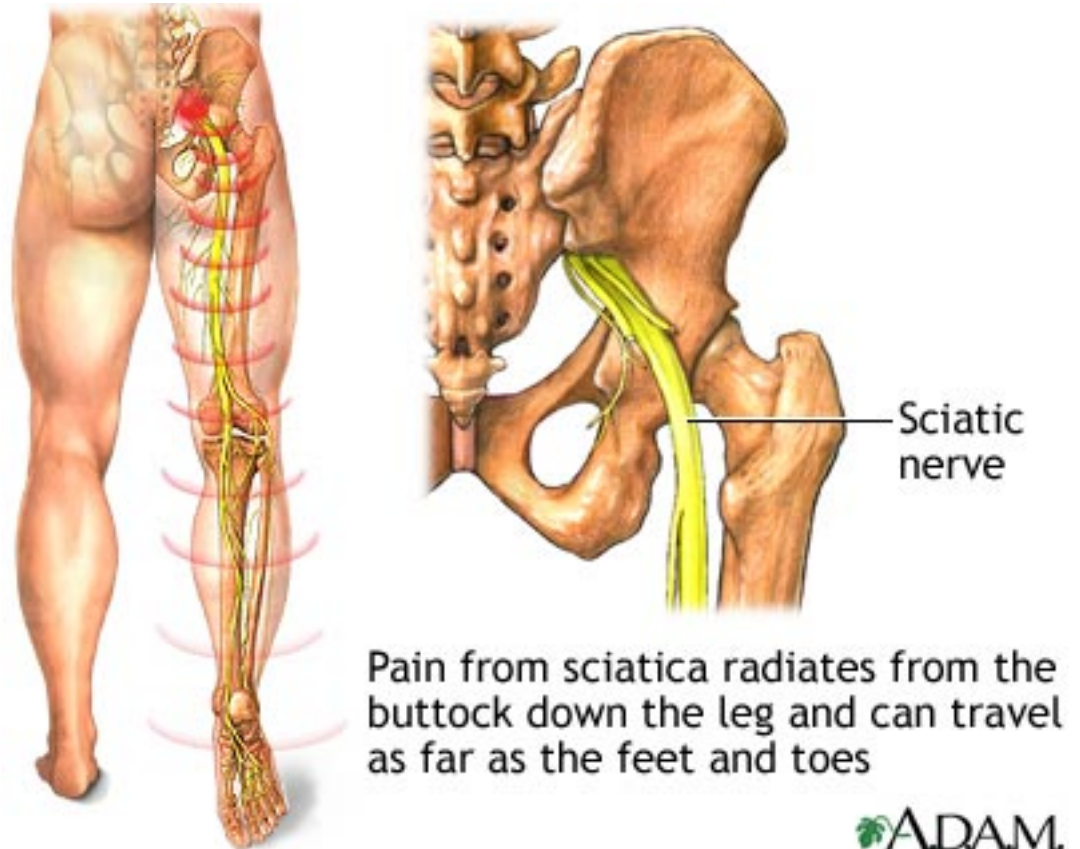


Source: Apothekenumschau

Chronic lower back pain

The symptoms during acute low back pain can include:

- Muscle ache
- Shooting/stabbing pain
- Pain that radiates down the leg
- Limited flexibility or range of motion

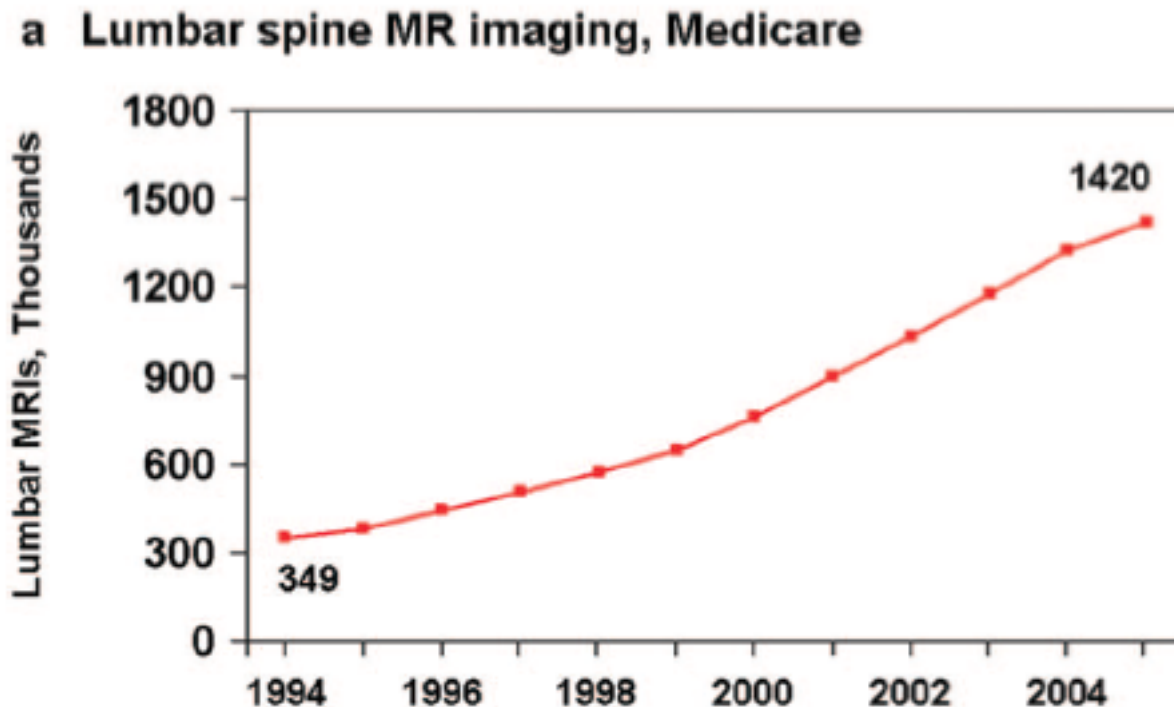


ADAM.

<https://www.nlm.nih.gov/medlineplus/ency/imagepages/19503.htm>

Chronic lower back pain

Only in ~20% of the cases (health information from Germany) can the cause be clearly identified. Nevertheless, the demand for imaging is surging (here for the US):

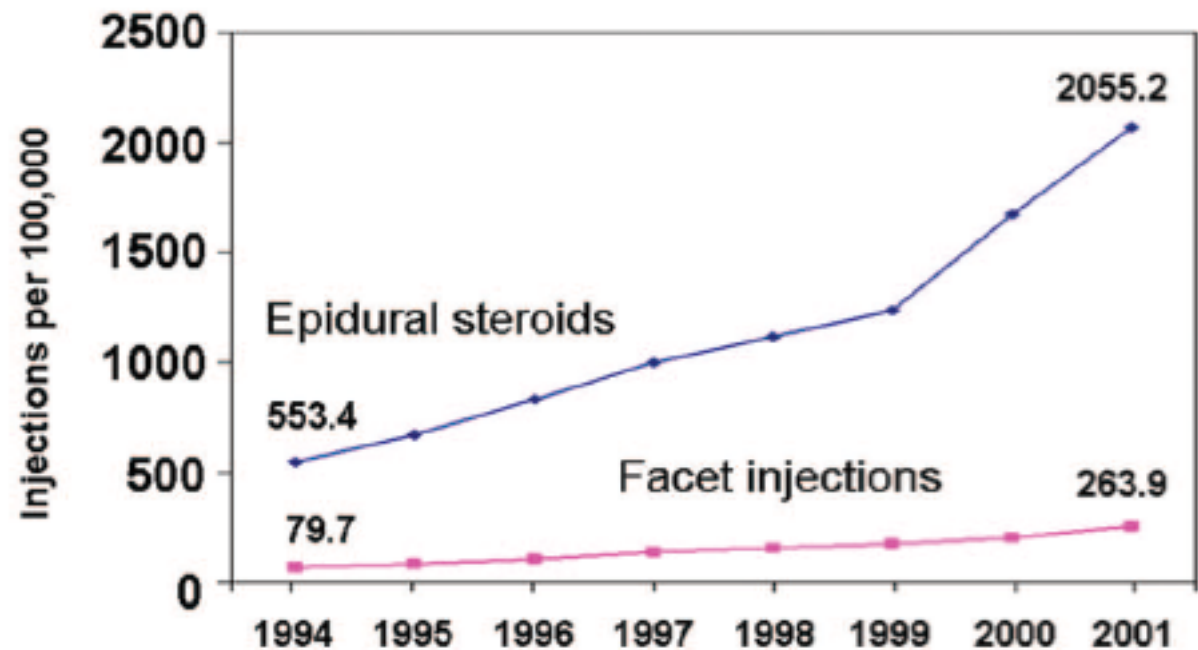


Imaging is often not very helpful: even in healthy, asymptomatic patients, imaging reveals irrelevant but alarming findings in ~2/3 of the cases.

Chronic lower back pain

The problem with these “false alarms” is that aggressive treatment might follow:

c Lumbosacral injection rates, Medicare



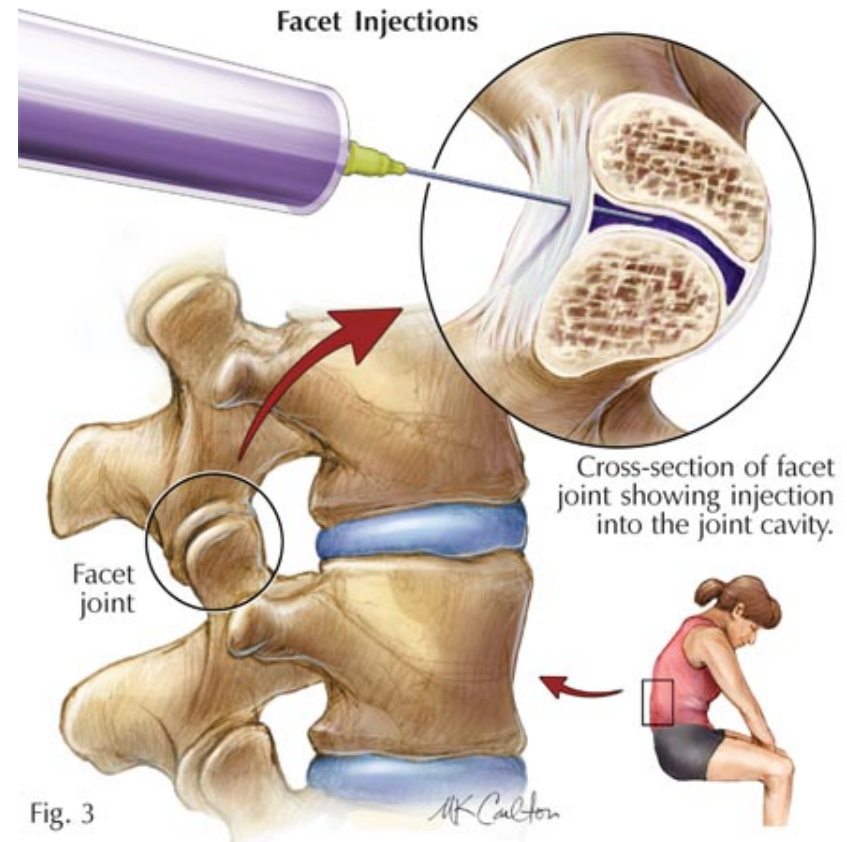
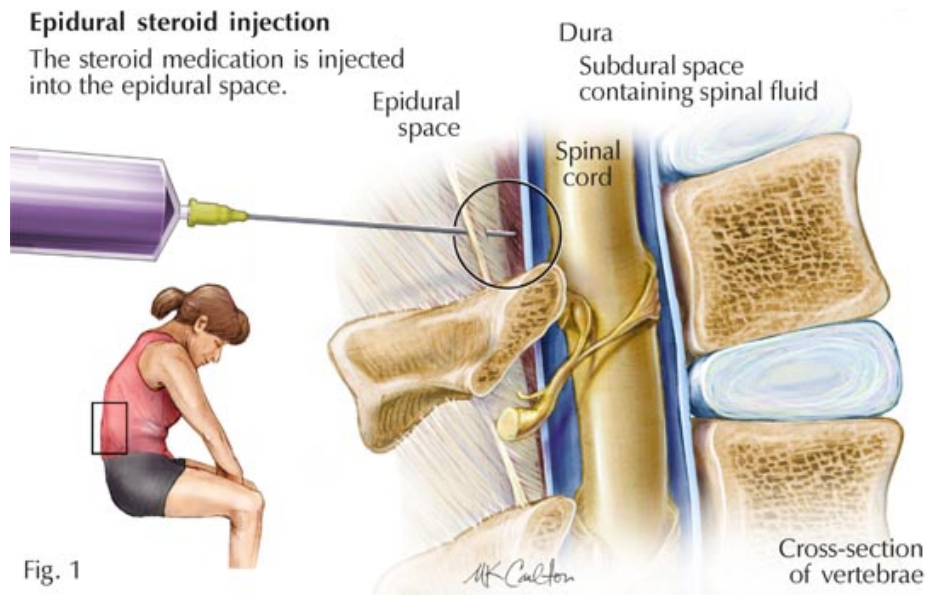
Lumbosacral injections:

Epidural steroids (cortisone) against inflammation, sometimes in combination with local pain-killer injected into skin.

Facet injection: similar injection into facet joints.

Chronic lower back pain

<http://www.spineinstitutenorthwest.com>



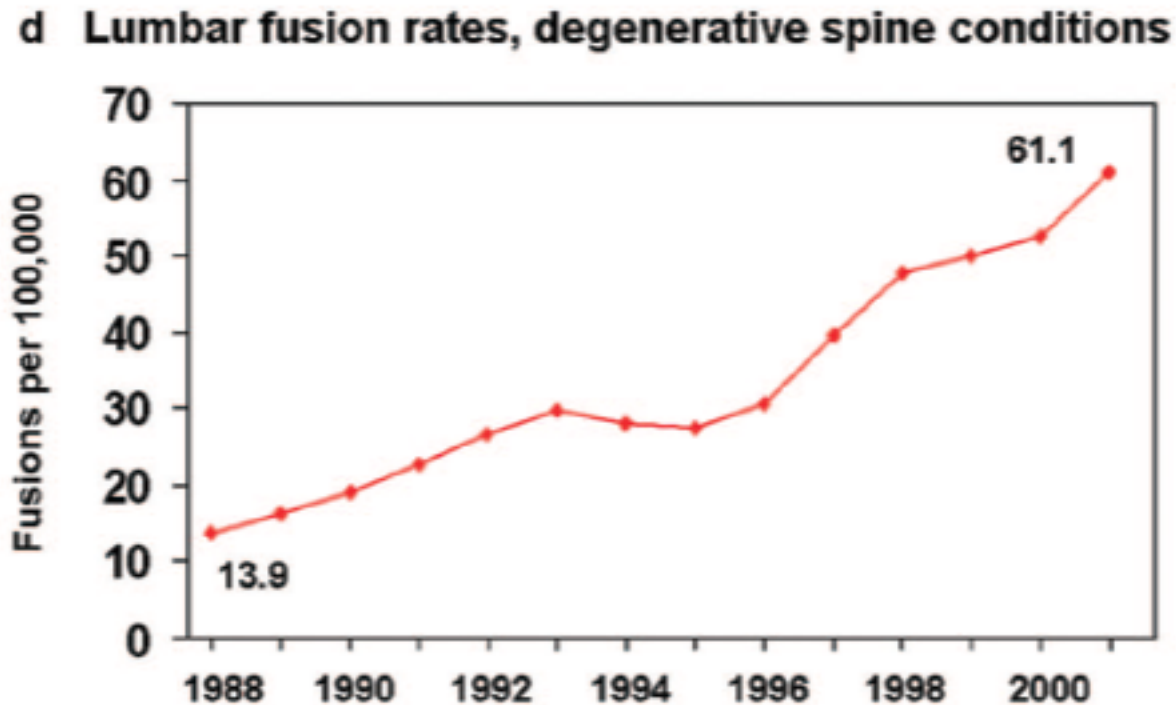
Lumbosacral injections:

Epidural steroids (cortisone) against inflammation, sometimes in combination with local pain-killer injected into skin.

Facet injection: similar injection into facet joints.

Chronic lower back pain

Another form of aggressive treatment that might follow is lumbar fusion:



Lumbar fusion involves fusion of two vertebrae to prevent the painful motion.

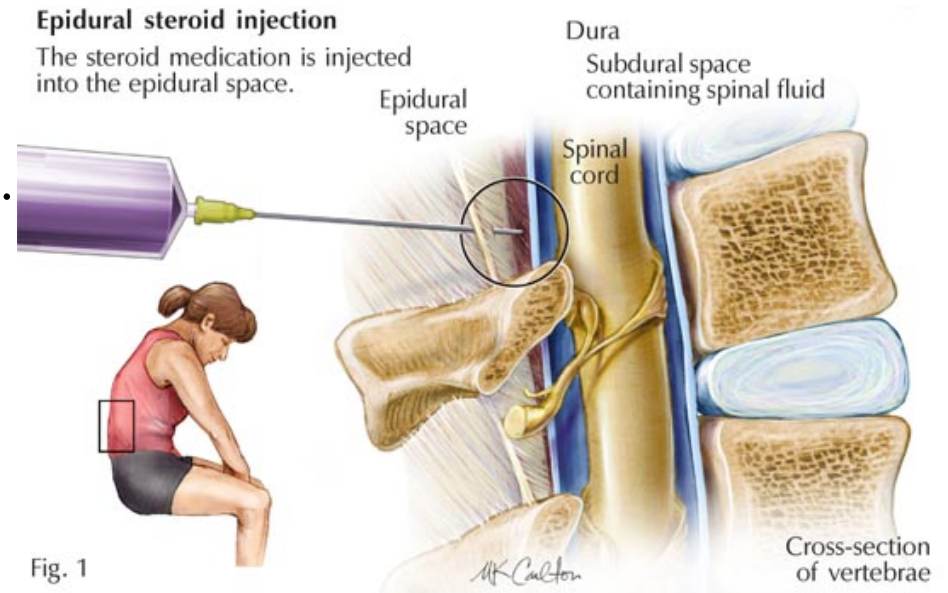
Chronic lower back pain

The usefulness of lumbar injections seems to be limited, systematic reviews suggest that they do not reduce later surgery rates. Facet injections with corticosteroids seem to be no better than saline solution.

Fusion surgery is helpful for fractures and deformities, but seem to be of limited value for treating disk degeneration with back pain alone.

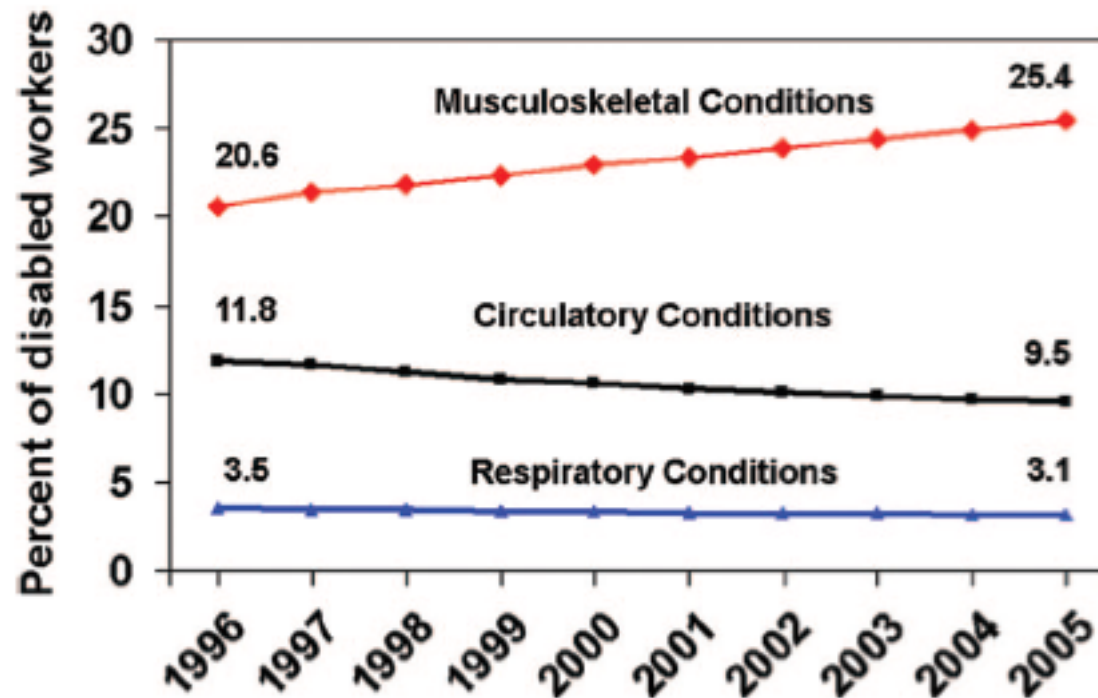
However, patients ask for a “quick fix” by injection or surgery.

But even if these measures are not helpful in all cases: you should go and see a doctor for your acute back pain, in particular when it was caused by a fall or trauma, or it gets worse over time, or it causes bowel/bladder problems, or it is accompanied by fever or weight loss.



Chronic lower back pain

Chronic low back pain has a social component, too: patients may become work disabled and may claim early retirement.



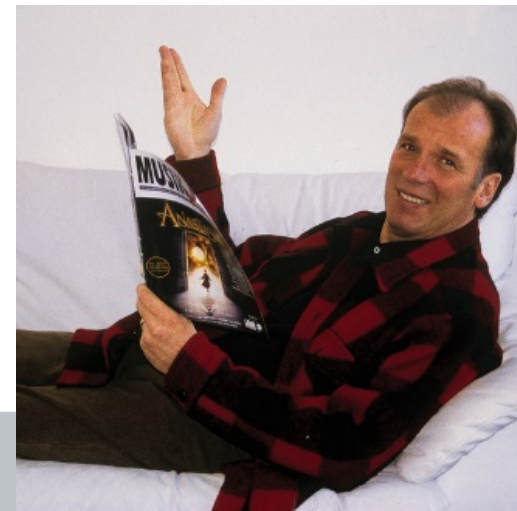
As shown in the graph, the proportion of disabled workers due to musculoskeletal conditions is increasing (US data).

Chronic lower back pain

From a learning theory perspective, patients may experience “rewards” when feeling pain:

- No need to go to work
- Early retirement
- Family might care more for patients
- “Back pain” as a physical impairment is more accepted than psychological ailments such as lack of motivation or depression.

Thus, instrumental conditioning (being rewarded for pain) can lead to intensified pain or more attentional focus on pain.



Chronic lower back pain

Multimodal treatment: Application of the biopsychosocial approach

- medical treatment of physical complaints
- strengthening of supporting muscles
- muscle relaxation
- pain diary
- cognitive-behavioral psychotherapy
- ergonomic workplace
- stress coping strategies

Kamper et al., BMJ, 2015: Cochrane systematic review and meta-analysis

What is already known on this topic

Multidisciplinary biopsychosocial rehabilitation programmes are widely used for people with chronic low back pain

Published reviews provide conflicting evidence regarding effectiveness of the programmes and do not quantify the size of the effects on key outcomes of pain, disability, and work absence

What this study adds

Based on the largest collection of trials and participants reviewed to date, this study provides robust estimates of the effects of multidisciplinary biopsychosocial rehabilitation programmes

Patients participating in these programmes are likely to gain small, long term benefits in improved pain and disability compared with usual care or physical treatments

They also have increased odds of being at work compared with patients receiving physical treatment

Patients participating in these programmes are likely to have a similar outcome to those receiving surgery but are less likely to experience adverse events

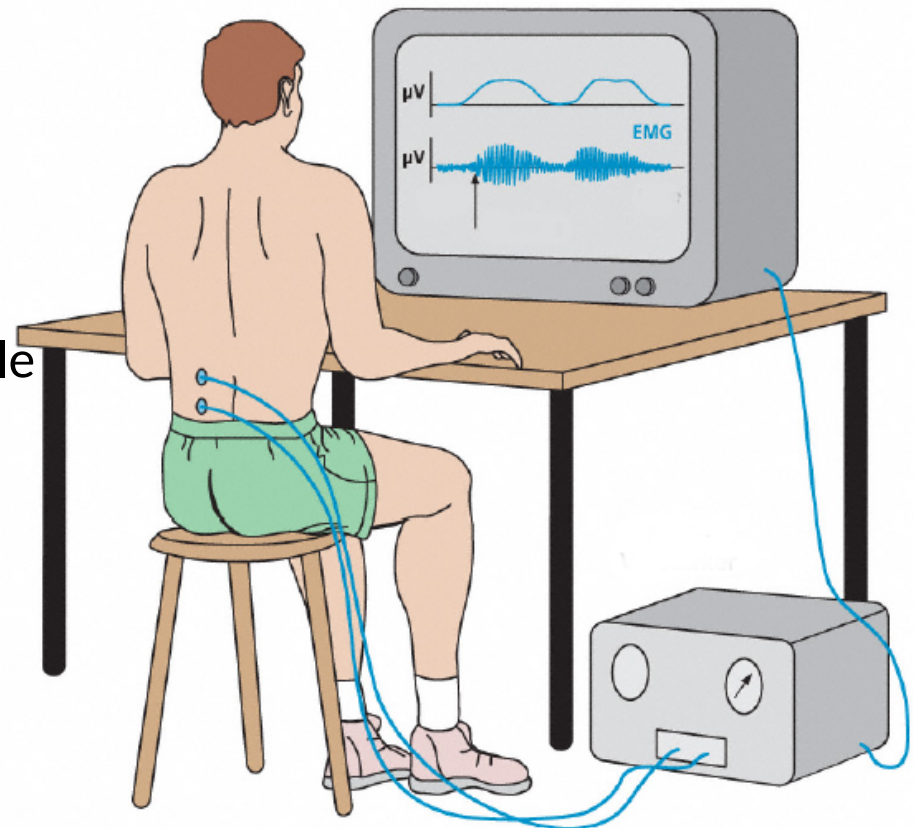
Chronic lower back pain

During acute pain, muscles are contracted and stiffened to protect tissue, skeleton. In chronic pain, this muscle tension can contribute to increased pain (by pressure) and decreased range of motion.

Muscle relaxation:
via progressive muscle relaxation

or bio-feedback:

EMG (electromyography) can be shown to patients in real-time. Patients learn to control and relax muscle tension with this feedback.



Chronic lower back pain

Pain diary:

There may be relationships between situations and the experience of pain:
Environment may be more caring when pain is expressed more.

(However, general social support has been shown to improve chronic pain; important is that social support should not be a consequence of the expression of pain).

Pain might occur when work is more stressful -> avoidance of work.

To understand these relationships and then address them, it is important to first clarify these relationships by logging the occurrence of pain.



Chronic lower back pain

In Japan, the Aichi Medical University (Nagoya) has a multidisciplinary pain center, founded in 2007, the first in Japan.

The screenshot shows the official website of Aichi Medical University. The browser address bar displays www.aichi-med-u.ac.jp/su10/su1008/index.html#FS01. The website header includes navigation links for '交通アクセス' (Access), 'キャンパスマップ' (Campus Map), and 'お問い合わせ先' (Contact Us), along with a search bar and an 'English' toggle. The main navigation menu features links for '法人案内' (Institutional Information), '大学案内' (University Information), '入試情報' (Admission Information), '学部' (Faculty), '大学院' (Graduate School), and '教育・研究施設' (Education and Research Facilities). The '教育・研究施設' section is expanded, showing a list of facilities: '医学情報センター(図書館)' (Medical Information Center (Library)), '情報処理センター' (Information Processing Center), '医学教育センター' (Medical Education Center), '先端医学研究センター' (Advanced Medical Research Center), '災害医療研究センター' (Disaster Medical Research Center), and '産業保健科学センター' (Occupational Health Science Center). The '学際的痛みセンター' (Interdisciplinary Pain Center) is highlighted. Below the center name, there are tabs for '活動・研究内容' (Activities and Research Content), 'スタッフ紹介' (Staff Introduction), '研究テーマ' (Research Themes), 'キーワード' (Keywords), '関連リンク' (Related Links), and '連絡先' (Contact Information). The main content area describes the center's mission: to provide comprehensive pain treatment and research by breaking down barriers between medical specialties and professions. It mentions the center was established in 2007 and is the first of its kind in Japan. The center's research focuses on 'interdisciplinary pain treatment system', 'clinical research', and 'pain education from a holistic perspective'. The center is currently conducting research and treatment for chronic lower back pain.

HOME > 教育・研究施設 > 学際的痛みセンター

学際的痛みセンター

- 活動・研究内容
- スタッフ紹介
- 研究テーマ
- キーワード
- 関連リンク
- 連絡先

学際的痛みセンターは、痛みのケアは診療科・職種の壁を越えて取り組むべきテーマであるという理念から日本で初めて創設された総合的痛み診療・研究施設です。診療科・職種の異なるエキスパートが協調して集学的・統合的な痛み治療を実践しています。また、本センターでは「学際的痛み診療システム」、「臨床に即した研究の推進」、「全人的観点からの痛み教育」という三つの柱を目標に掲げ、痛みの実態解明に関する研究と痛み治療に取り組んでいます。

Chronic lower back pain

Von Korff et al. (Pain, 2005) investigated a population of ~5700 US citizens;
within 1 year:

- 19% showed chronic spinal pain

of those:

- 69% showed another type of chronic pain

- 35% showed mental disorders

 - in particular

 - anxiety disorders

 - mood disorders (depression)



Summary: Chronic Pain

Chronic pain

- Basics of pain perception (Nociception)
nociceptors, spinothalamic pathway, thalamus, somatosensory cortex, insula, anterior cingulate cortex
- Top-down control of pain perception
PAG, opioid receptors, ventrolateral and dorsolateral prefrontal cortex, attentional modulation
- Chronic low back pain
psychological factors: e.g., attention, learning
- Treatment strategies for chronic low back pain
cognitive-behavioral psychotherapy, muscle relaxation, pain diary