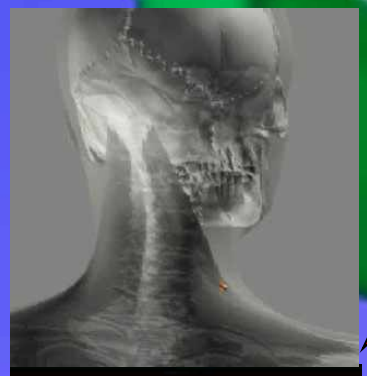
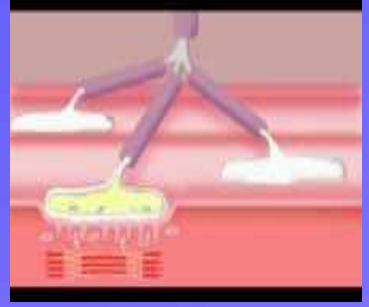
The Role of Central Sensitization and Neurogenic Inflammation in Myofascial Pain Syndrome

Jay P. Shah, MD

Traditional View of Myofascial Pain and Trigger Points

"Acute" Musculoskeletal Pain





Peripheral

Central

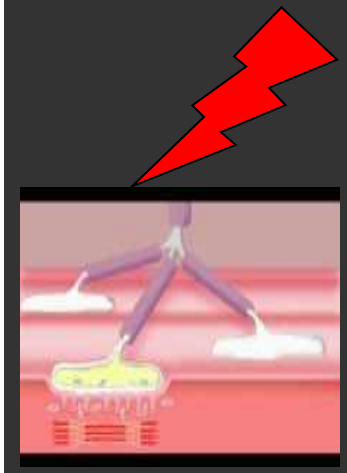
Chronic Pain

Disuse
Depression
Disability

Central Sensitization Syndrome

Peripheral vs. Central Sensitization

Active MTrPs Associated with *Limbic System Dysfunction*



Pain Perception and the Human Brain

The Phases of Nociceptive Pain

Peripheral

Central

Spectrum of Sensitization

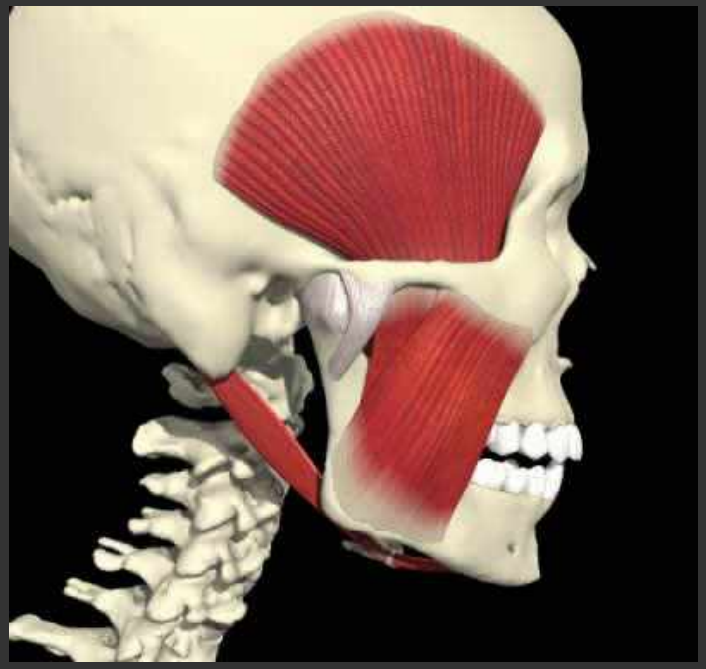
Myofascial Pain Syndrome

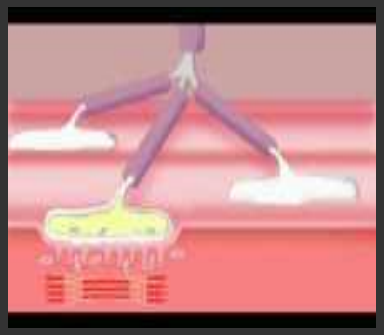
Myofascial Pain Syndrome – a pain condition that may be acute or - more commonly - chronic and involves the muscle and its surrounding connective tissue (e.g., the fascia)

Travell and Simons – Myofascial Trigger Points (MTrPs) are central to the Dx of MPS

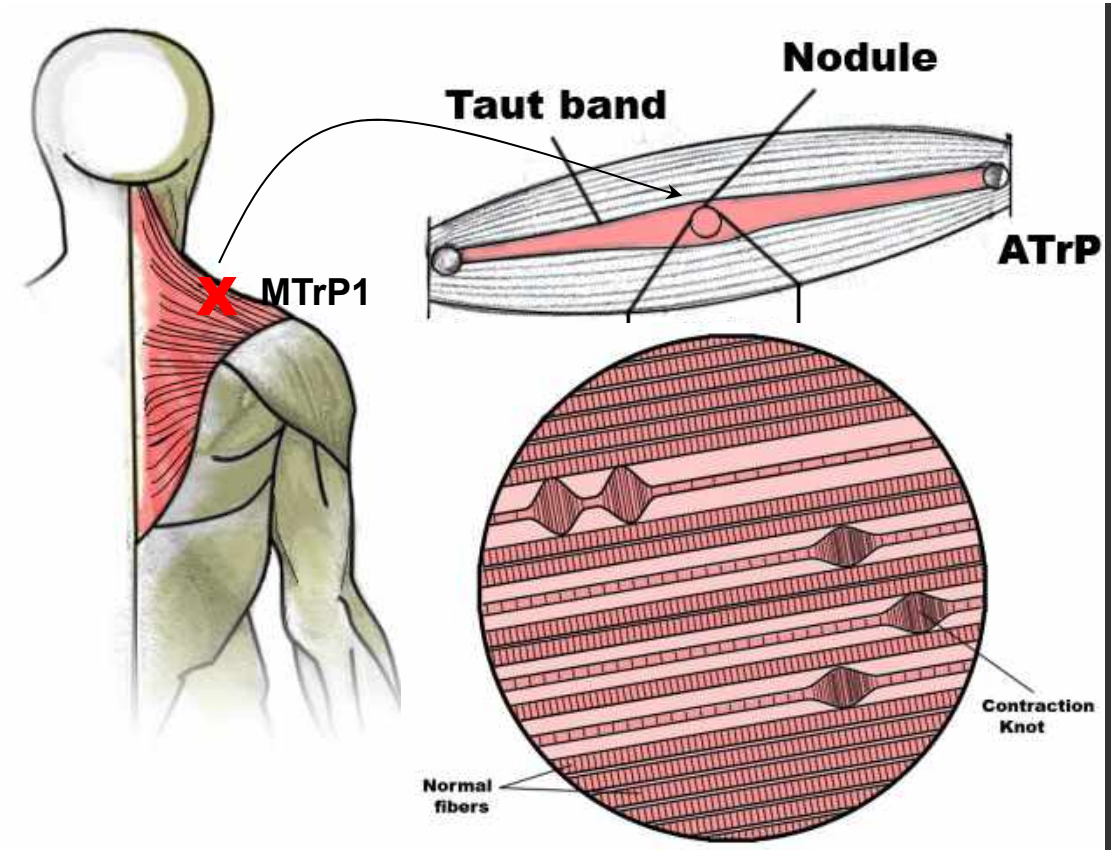
- MTrPs commonly found in asymptomatic individuals (i.e., Latent MTrPs)

MTrPs are sufficient but are they necessary??





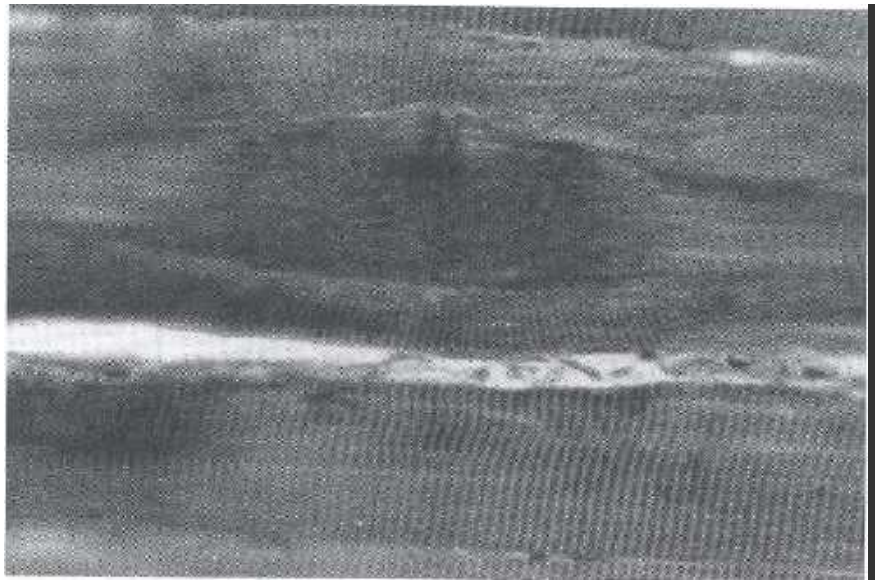
The Trigger Point Manual.
Simons, Travell and Simons, 1999



Trigger Point– Hard palpable nodules in *taut* bands of skeletal muscle.

Active – spontaneous pain or other abnormal sensory symptoms

Latent – no spontaneous pain, but show all the other characteristics of active MTrPs



The Trigger Point Manual.
Simons, Travell and Simons, 1999

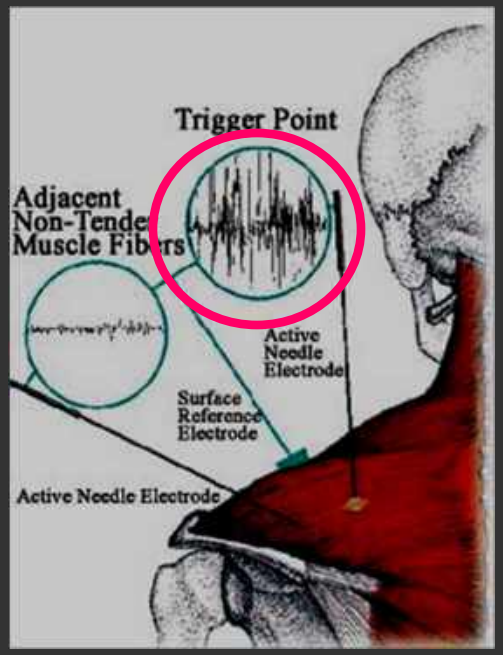
Simons' Integrated Hypothesis

Pathophysiology

Increased Miniature Endplate Potentials (Endplate Noise)

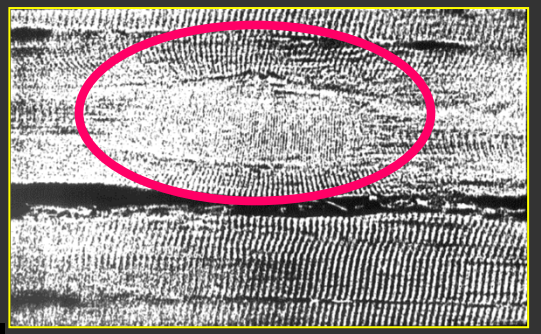
Histopathology

Increased Fiber Tension (Taut Band)



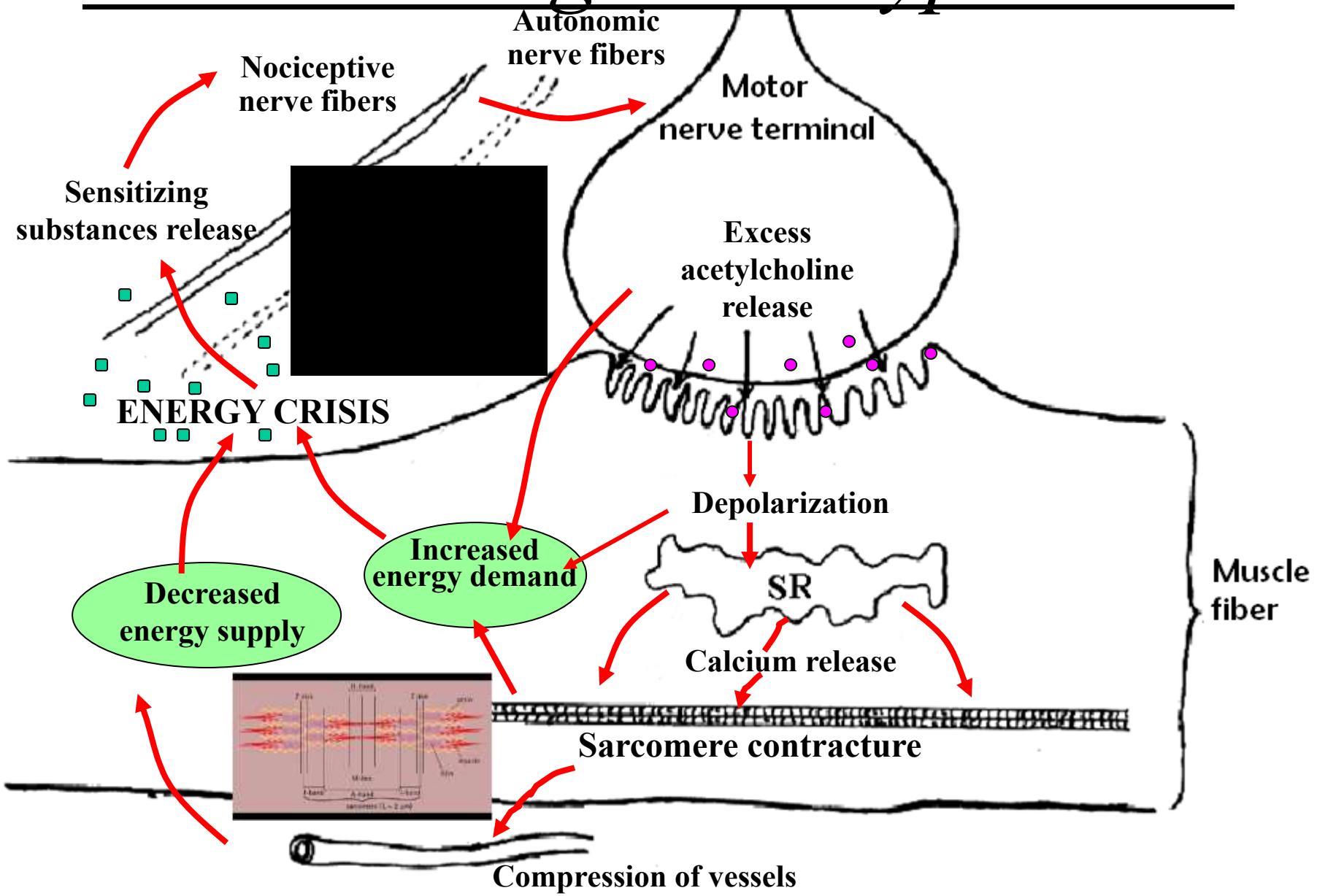
Histochemistry

Release of Sensitizing Substances? (Pain)

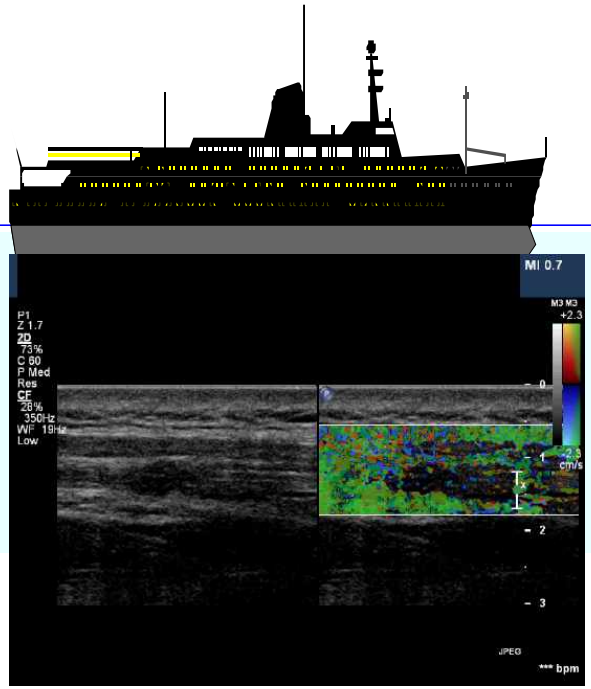


The Trigger Point Manual. Simons, Travell and Simons, 1999

Simons' Integrated Hypothesis

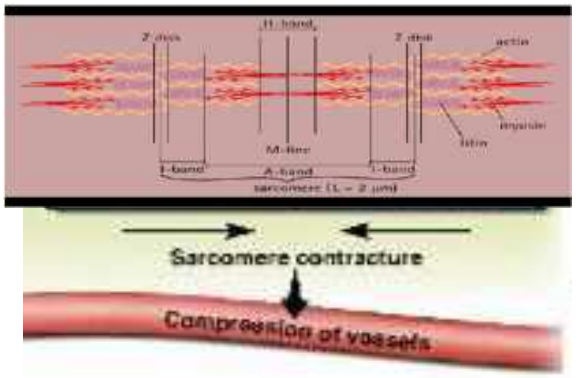


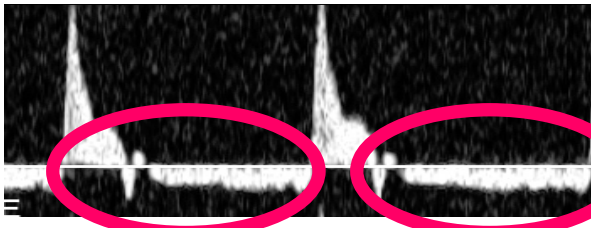
Is Simons' Hypothesis about the Biochemical Milieu, Viscoelastic Properties and Ischemia/Hypoxia associated with MTrPs Correct?



Clinical findings

Underlying milieu?





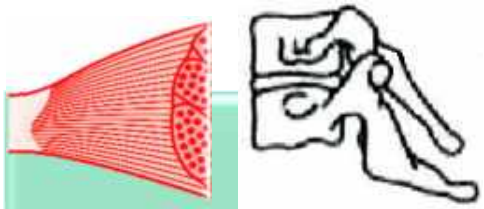
Muscle Overload/Injury?

The activation of a myofascial trigger point (MTrP) is associated with some degree of mechanical abuse of the muscle in the form of muscle overload, which may be acute, sustained, and/or repetitive.

The Trigger Point Manual.
Simons, Travell and Simons, 1999

Several clinical observations have emerged to challenge the local injury mechanism of the Integrated Hypothesis.

MTrPs are commonly observed with a number of musculoskeletal and *non-musculoskeletal pain* syndromes in the absence of injury to the affected muscle



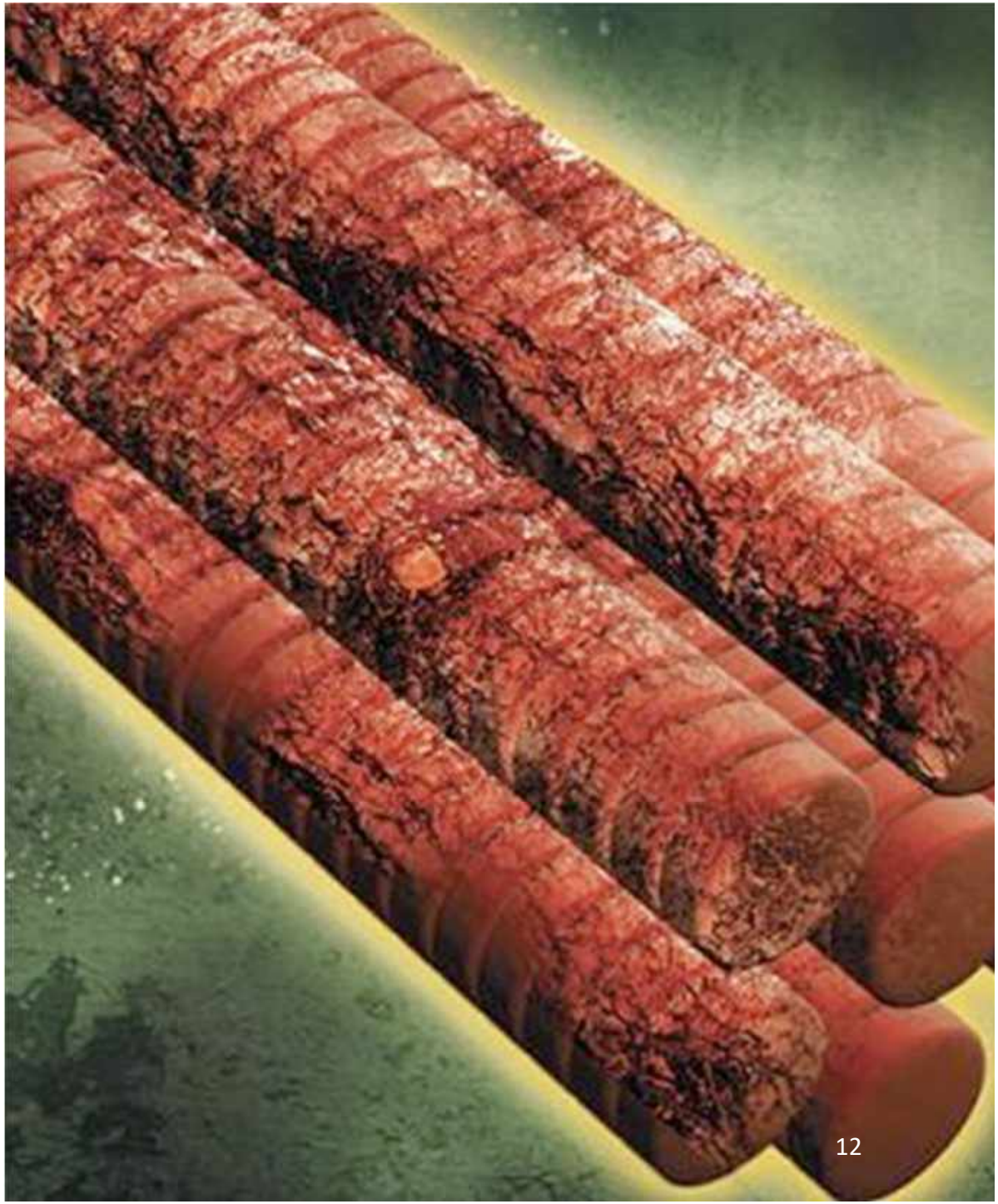
- **Disc pathology (Hsueh, 1998)**
- **Tendonitis (Wang, 2006)**
- **Craniomandibular dyfunction (Dommerholt, 2006)**
- **Carpal tunnel sx (Skubick, 1993)**
- **Computer related disorders (Treaster, 2006)**
- **Spinal dysfunction (Fruth, 2006)**

- **Post herpetic neuralgia (Weiner, 2006)**
- **Complex regional pain syndrome (Dommerholt, 2004)**
- **Phantom pain (Kem, 2006**
- **Migraine (Calandre 2006)**
- **Tension type headache (Fernandez-de-las-Penas, 2005, 2006)**
- **Radiculopathy (Rosomoff, 1989)**
- **Joint dysfunction (Bajaj, 2001)**

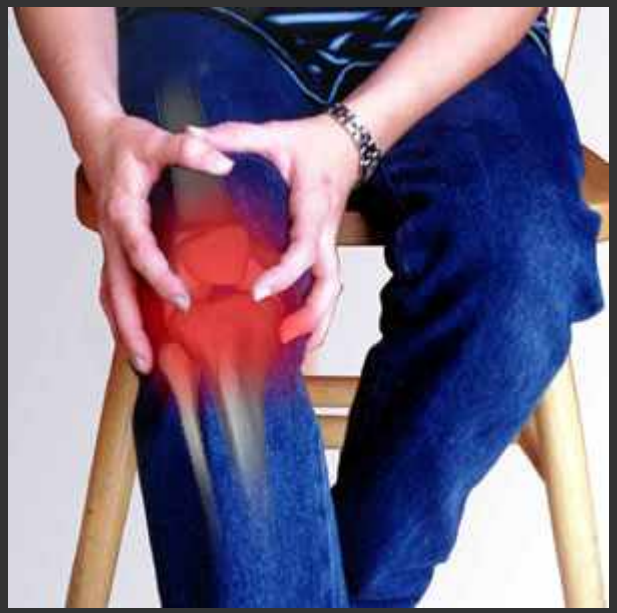
- **Pelvic pain/Urologic syndromes (Weiss, 2001)**
- **Neurogenic pruritus (Stellon, 2002)**
- **Chronic Prostatitis (Anderson, 2006)**
- **Internal Cystitis/bladder syndrome (Fitzgerald 2012)**
- **Chronic pelvic pain syndrome (Anderson, Wise, Sawyer, Nathanson, 2011; Stratton, Shah. 2015)**
- **Barrie-Lieou Syndrome (Longbottom, 2005**

Mechanical overload injury of the myotendinous unit leads to:

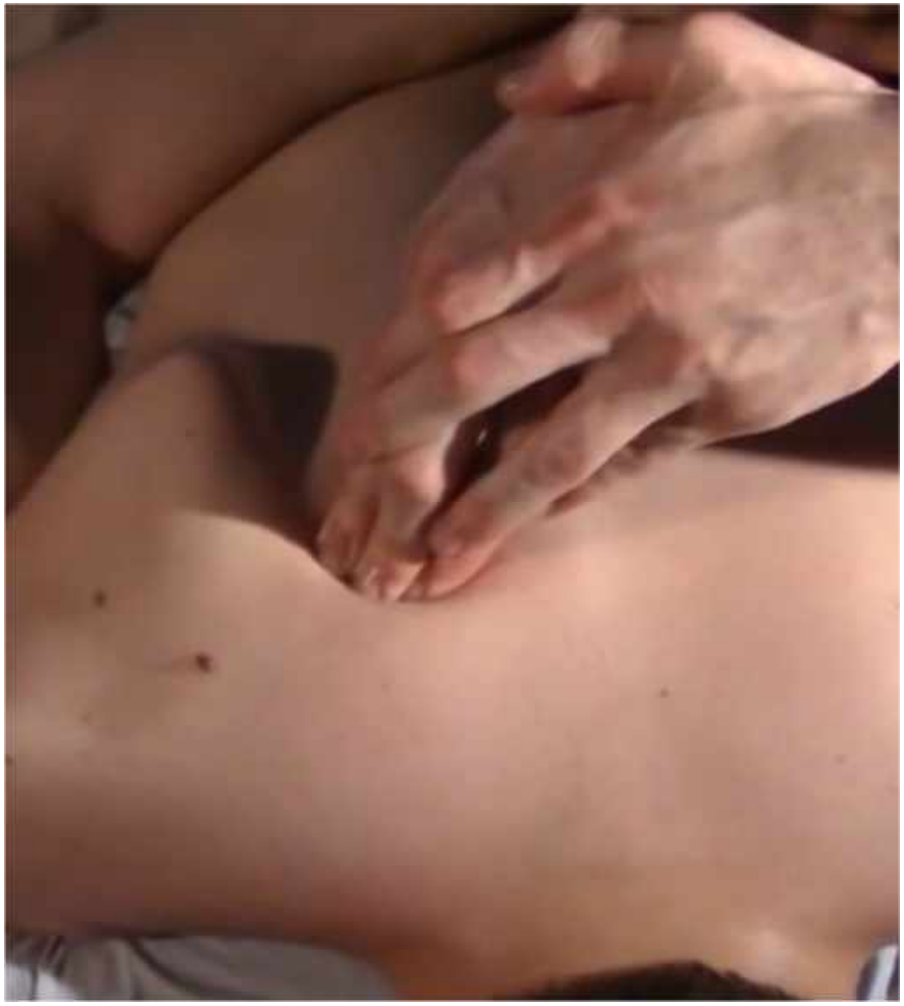
- “acute pain”
- sharp and well-localized
- pressure on muscle induces a withdrawal reflex



Pressure on a MTrP does NOT induce a withdrawal reflex.

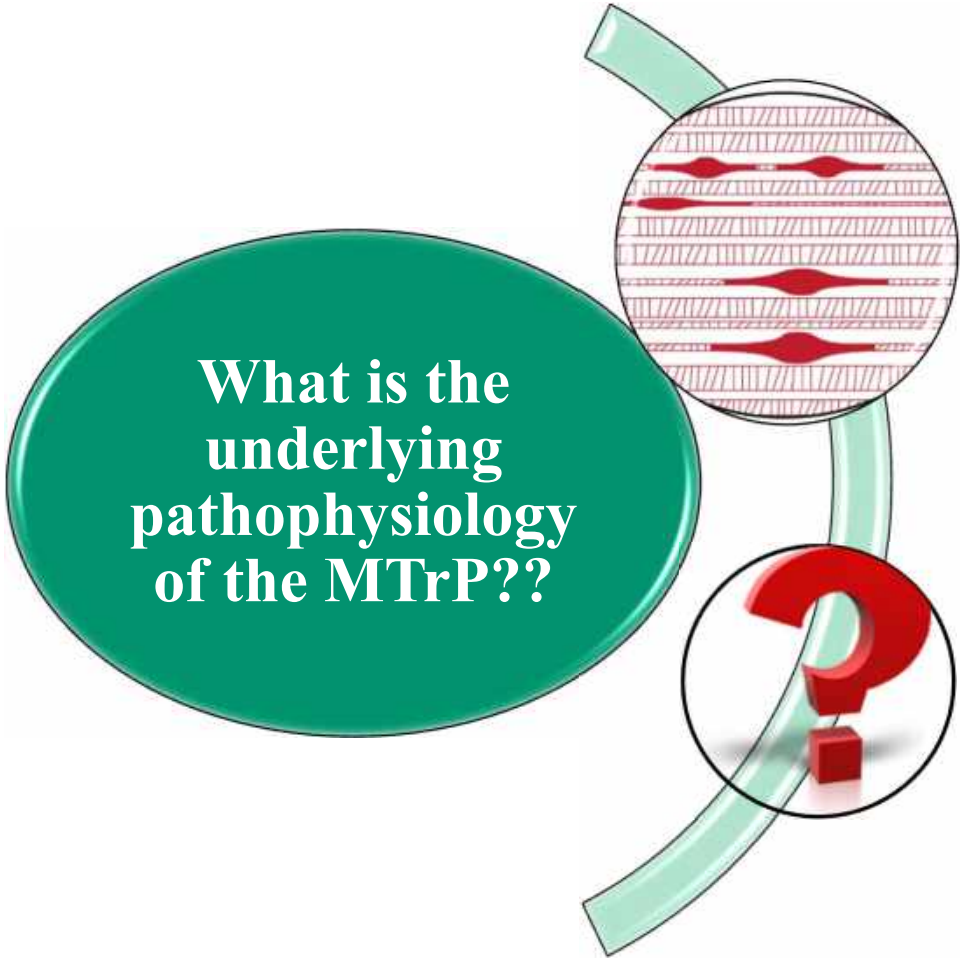


The myofascial trigger point region does not behave like a local injury



- NO withdrawal reflex
- Pain character:
  - Deep, achy
  - Often diffuse, poorly localized
- “good pain”
- “more pressure”
- Gradually decreasing pain with sustained pressure

Myofascial Pain
Central Outstanding Question



"Is the MTrP the **primary pathology** in Myofascial Pain Syndrome (MPS) or is MPS a clinical manifestation of an underlying physiologic mechanism?"

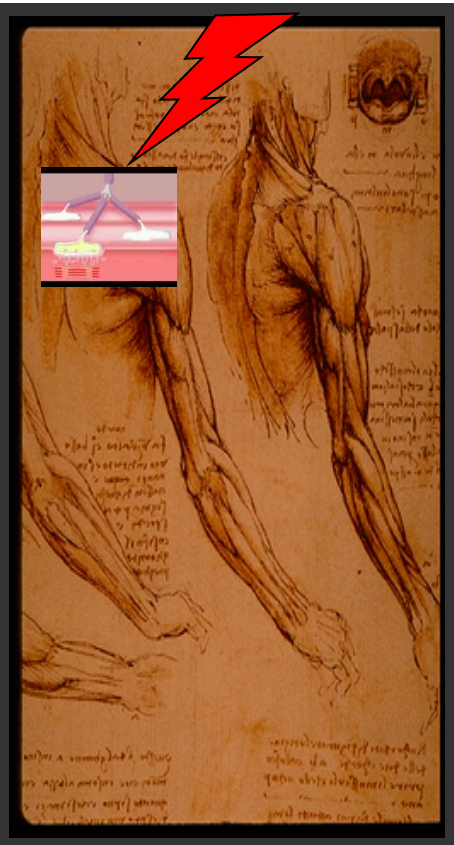
Is the MTrP the "Cause or Effect"?

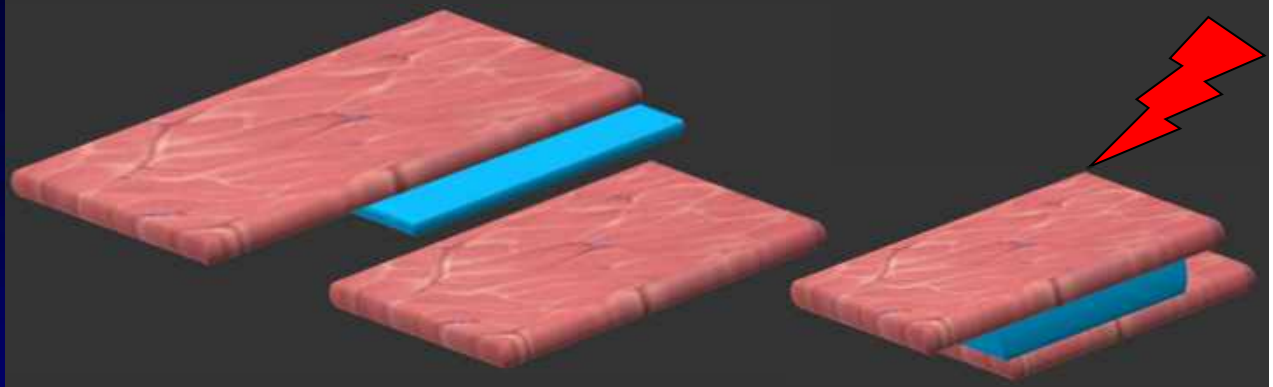
Myofascial Trigger Points:

Doors are Opening Worldwide

Myofascial Pain Syndrome

- What is the role of the muscle?
- What is the role of the MTrP?
- What happens when a MTrP becomes *active* (i.e., spontaneously painful?)
- What is the role of the nervous system and brain?
- What is the role of the fascia?





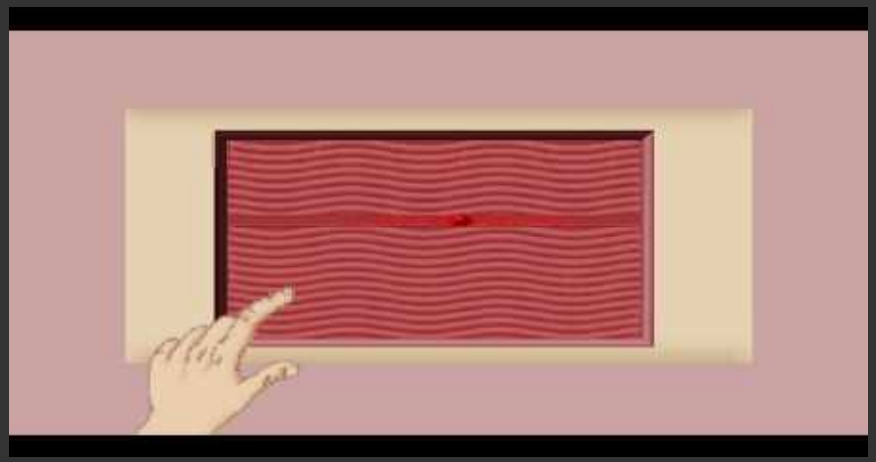
MYO-FASCIAL

PAIN SYNDROME

Courtesy Antonio Stecco, MD

Active MTrPs have Unique Biochemical Milieu

Active MTrPs have a unique biochemical milieu of substances (e.g., inflammatory mediators, neuropeptides, catecholamines and cytokines) associated with inflammation, sensitization, persistent pain states and inter-cellular signaling



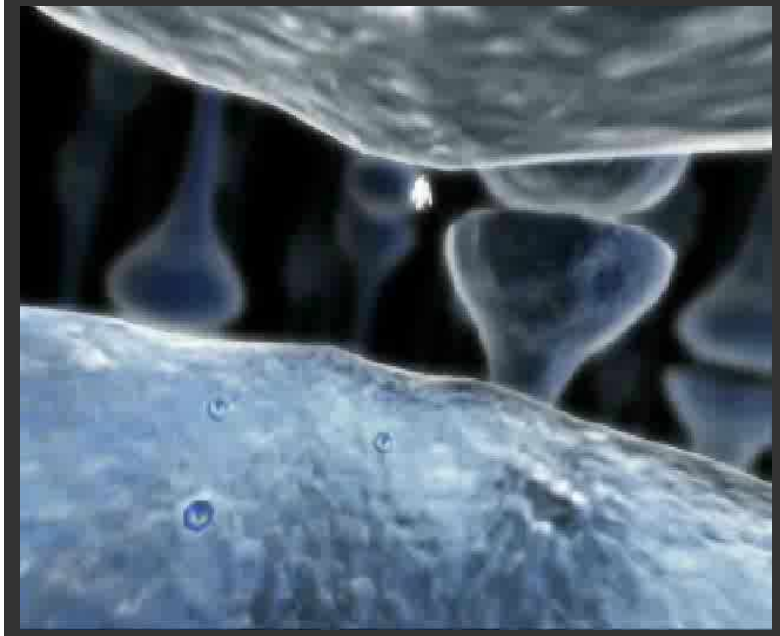
Shah et. al. *J of App Physiol*. 2005

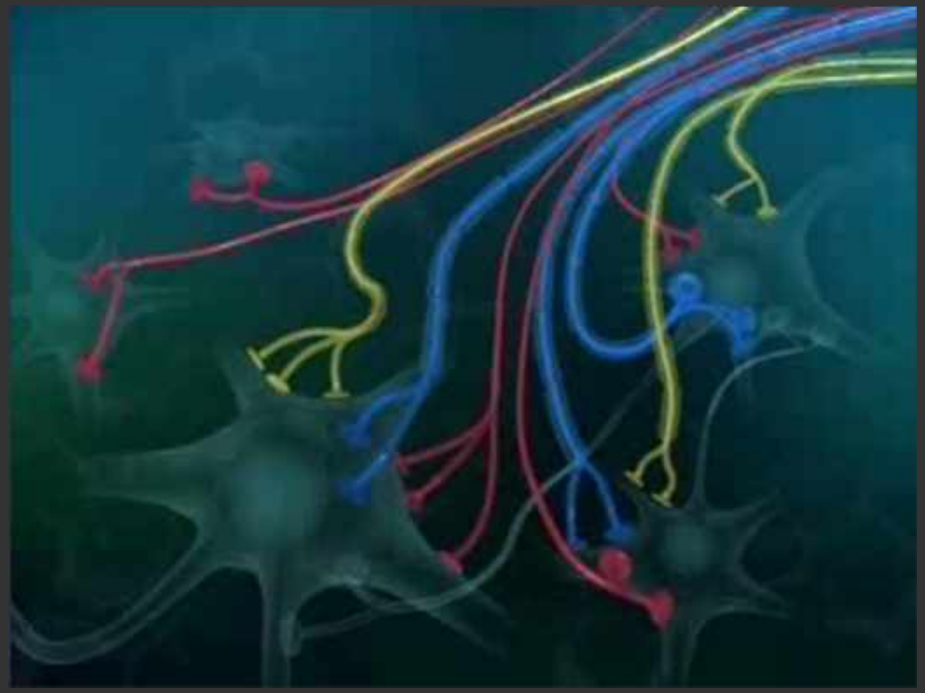
Shah et. al. *Archives of PM&R*. 2008

MTrPs and Central Sensitization

"MTrPs are not merely a peripheral phenomenon - the input from MTrPs leads to hyperexcitability of central neurons that manifests in allodynia, hyperalgesia and pain referral" Mense, S. *Journal of Musculoskeletal Pain*, 2010

"These central changes are mainly based on an increase in the synaptic efficacy of central connections induced by nociceptive input." Mense, S. *Journal of Musculoskeletal Pain*, 2010

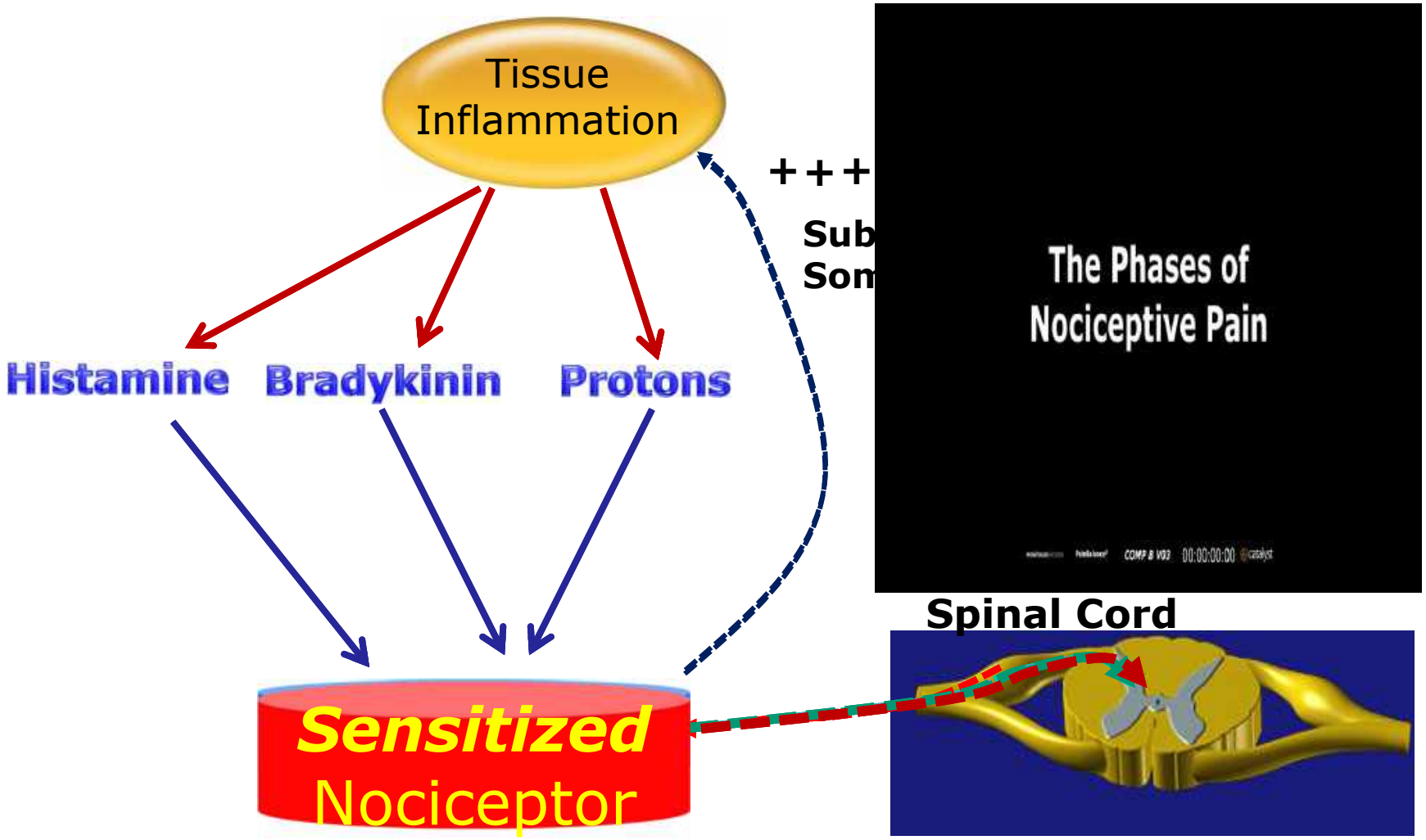




Myofascial Trigger Points, Sensitization, Neurogenic Inflammation and *Neuro*-musculoskeletal Pain

From Peripheral to Central Sensitization and *Back*!

Neurogenic Inflammatory Cycle



Courtesy Pedro Romero Ventosilla, MD

Communication of Critical Information Occurs in Two Opposite Directions *Simultaneously* between the Nociceptor and Spinal Cord

Neurogenic Inflammation Occurs in Neuropathic Pain, Inflammatory Pain, and Complex Regional Pain Syndrome

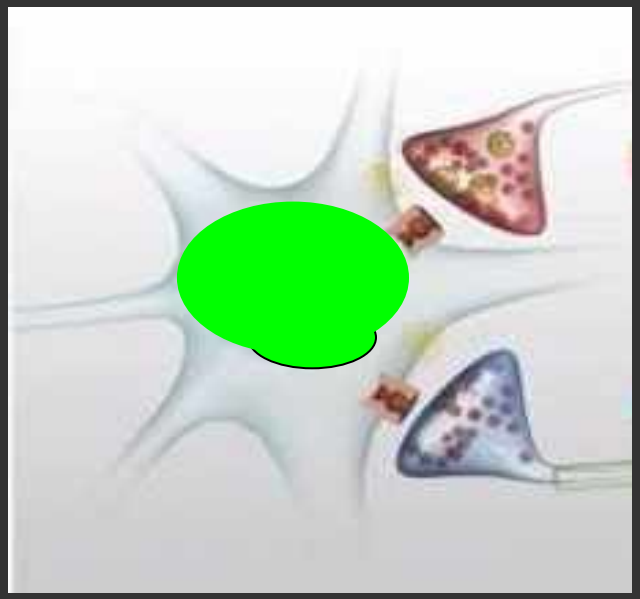
The Sensation of Pain Depends upon the Balance of Sensitizing and Desensitizing Actions

Sensitized Dorsal Horn Neurons Demonstrate:

1) *Increased responsiveness* to external stimuli

2) *Spread of excitation* to spinal segments that do not normally receive input from the damaged muscle

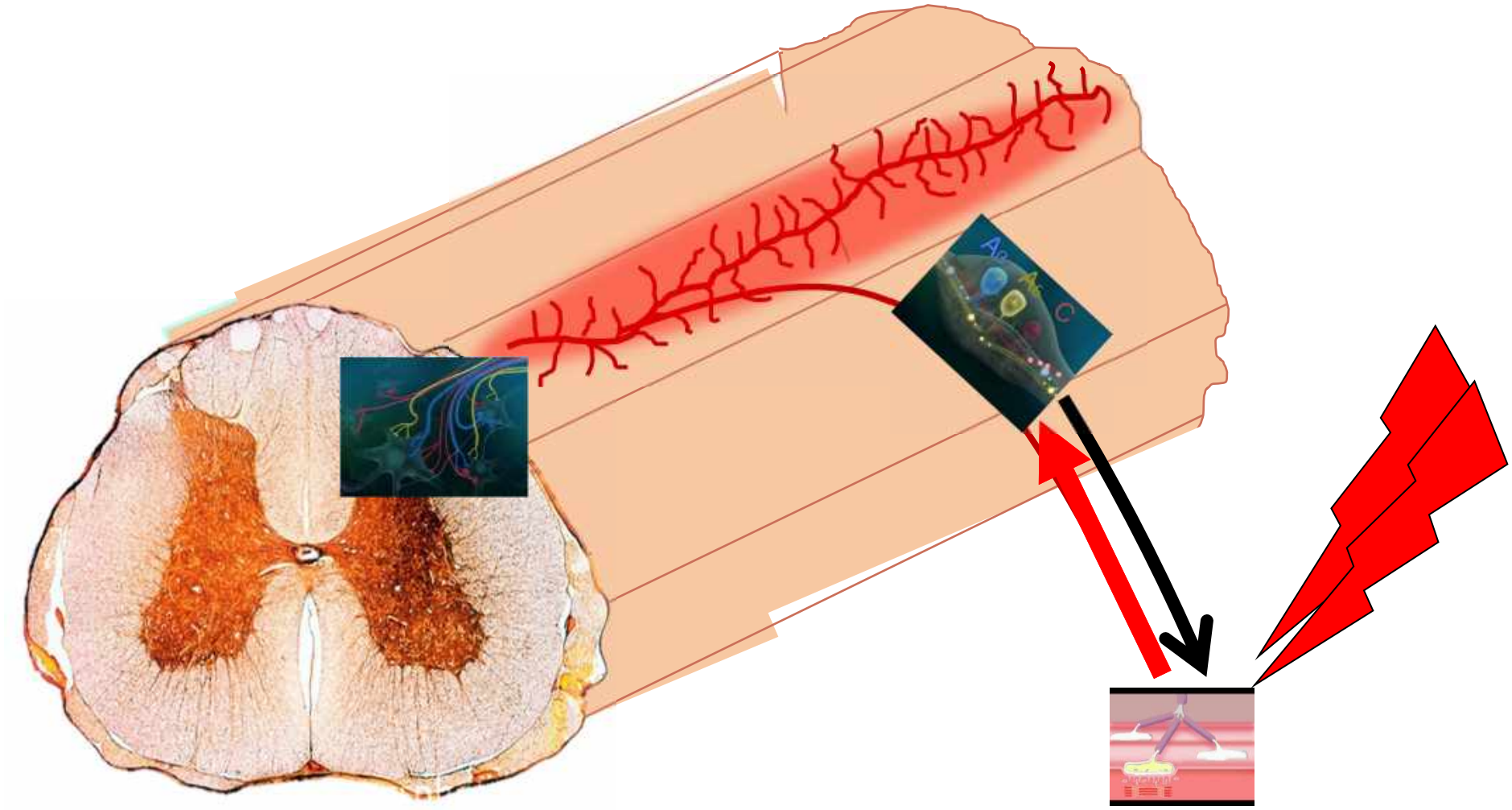
3) *Increased background* activity



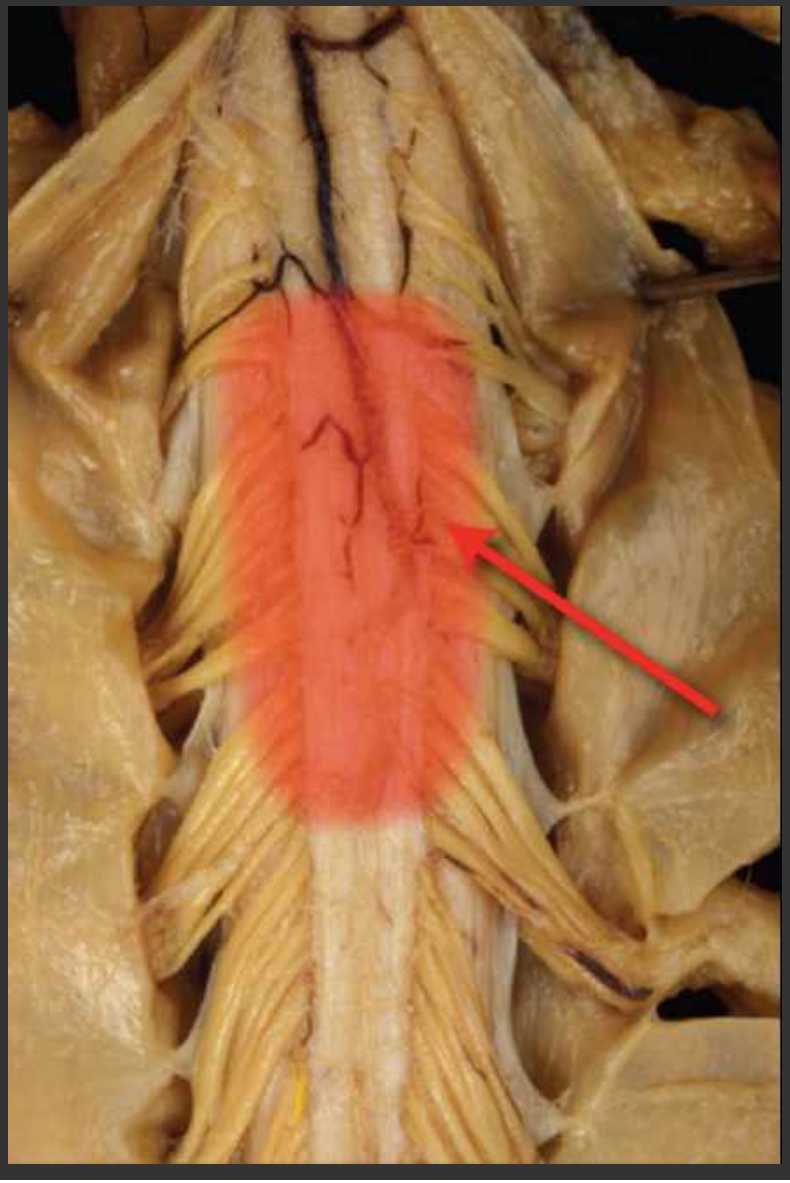
Excitatory tonus via Nociceptors

Inhibitory tonus via Mechanoreceptors

Sensitized Dorsal Horn Neurons Demonstrate *Extra*-Segmental Spread of Excitation!



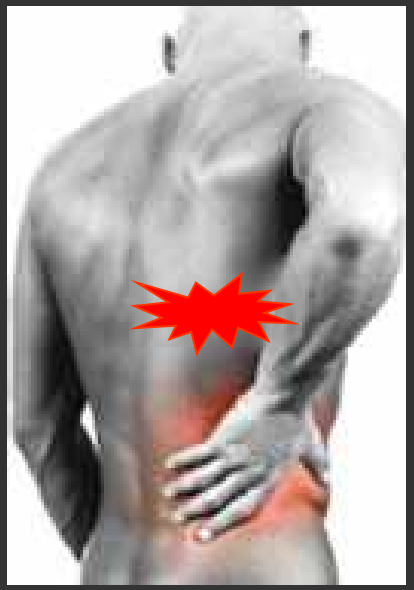
Sensitized Dorsal Horn Neurons Demonstrate *Extra*-Segmental Spread of Excitation!

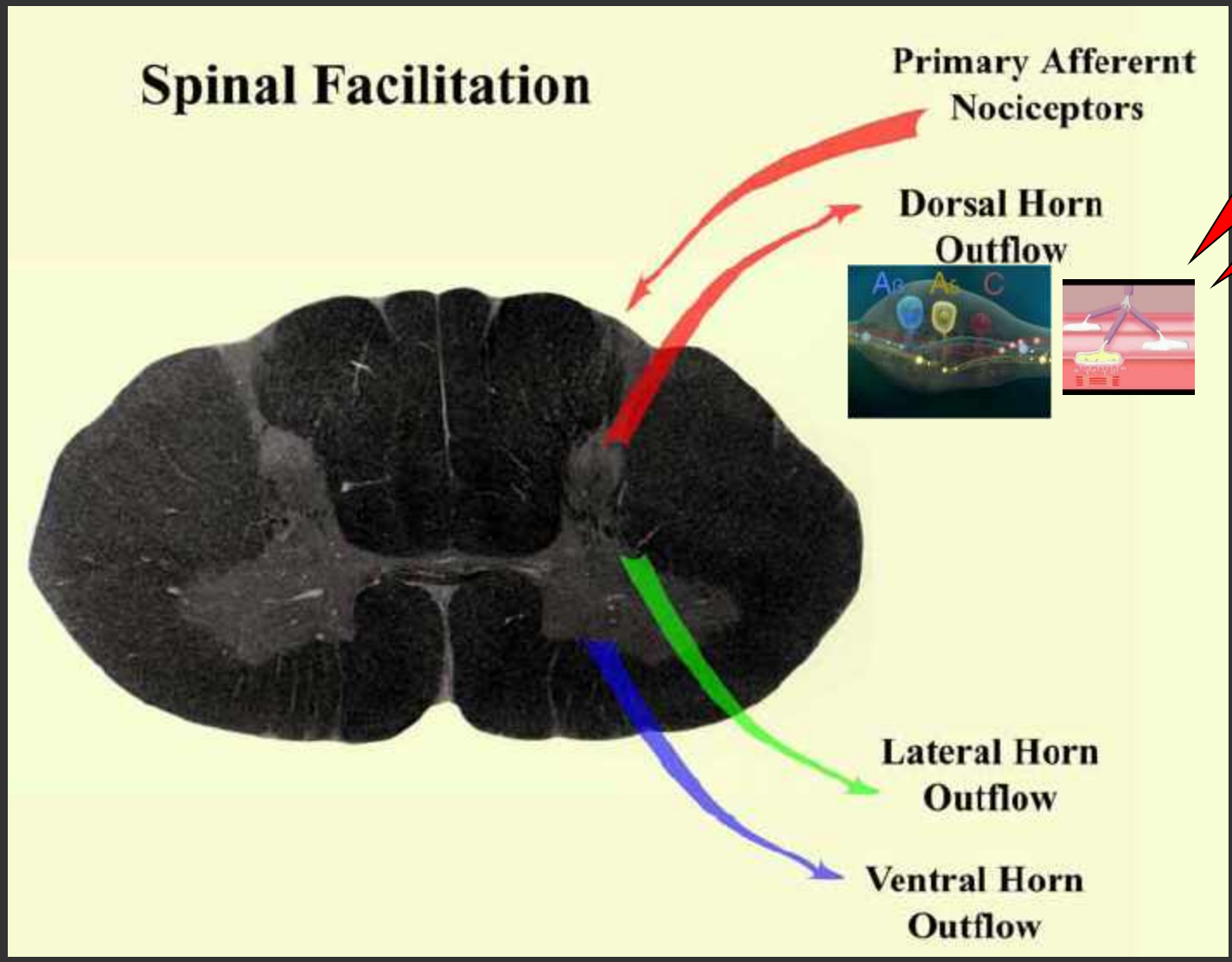


Courtesy Frank Willard

Sensitized Dorsal Horn Neurons Demonstrate *Extra*-Segmental *and* Contralateral Spread of Excitation!

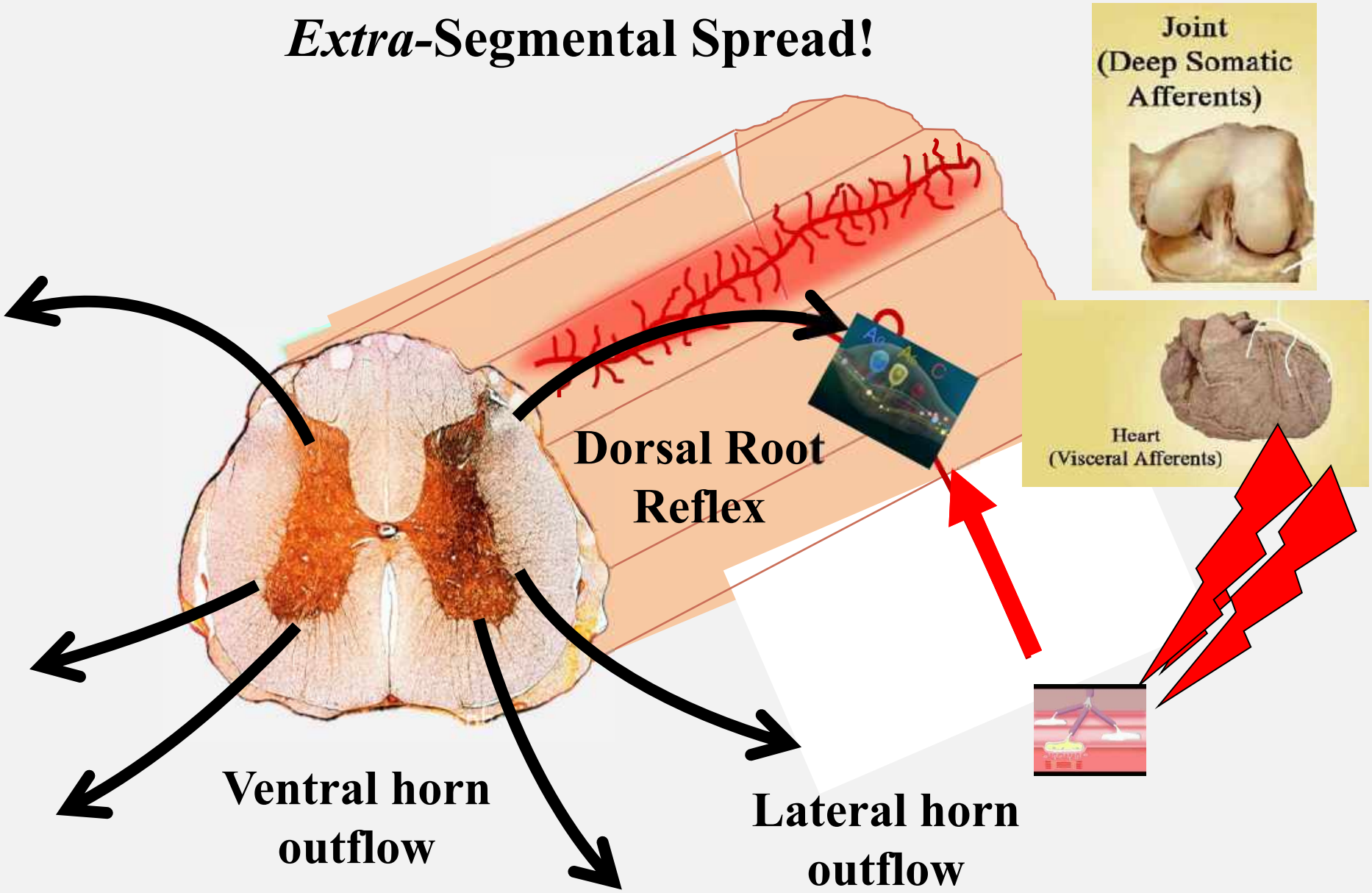
Mirror-Image Pain





Courtesy Frank Willard

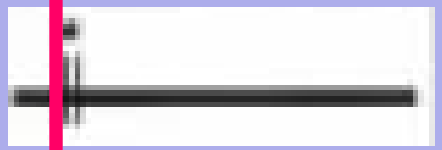
Sensitized Dorsal Horn Neurons Demonstrate *Extra*-Segmental Spread!



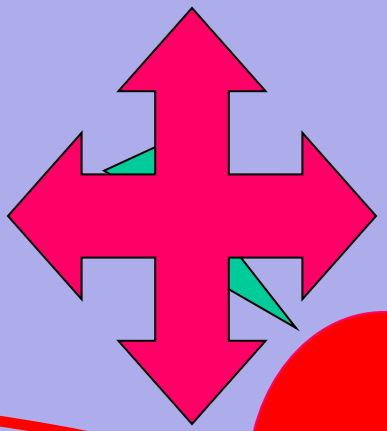
How Many Noxious Stimuli are Needed to Induce Spontaneous Discharge of the Dorsal Horn Neuron?

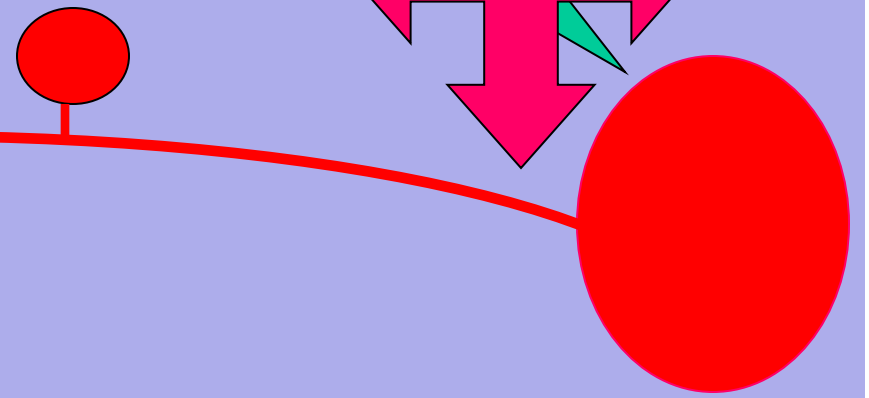
"Wind Up"

Stimulation



Extracellular recording





Receptive field

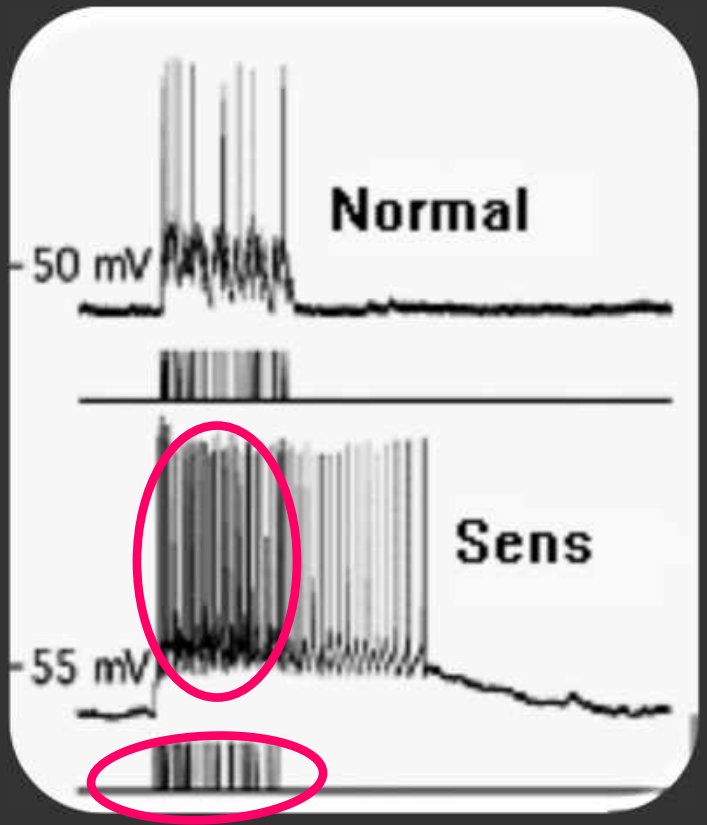
Spontaneous discharge activity after 150 stimuli

Zieglgansberger W. *Scand J Rheum*
2000;29 113:19-23

Wind-up and Central Sensitization are induced by Persistent Nociceptive Bombardment

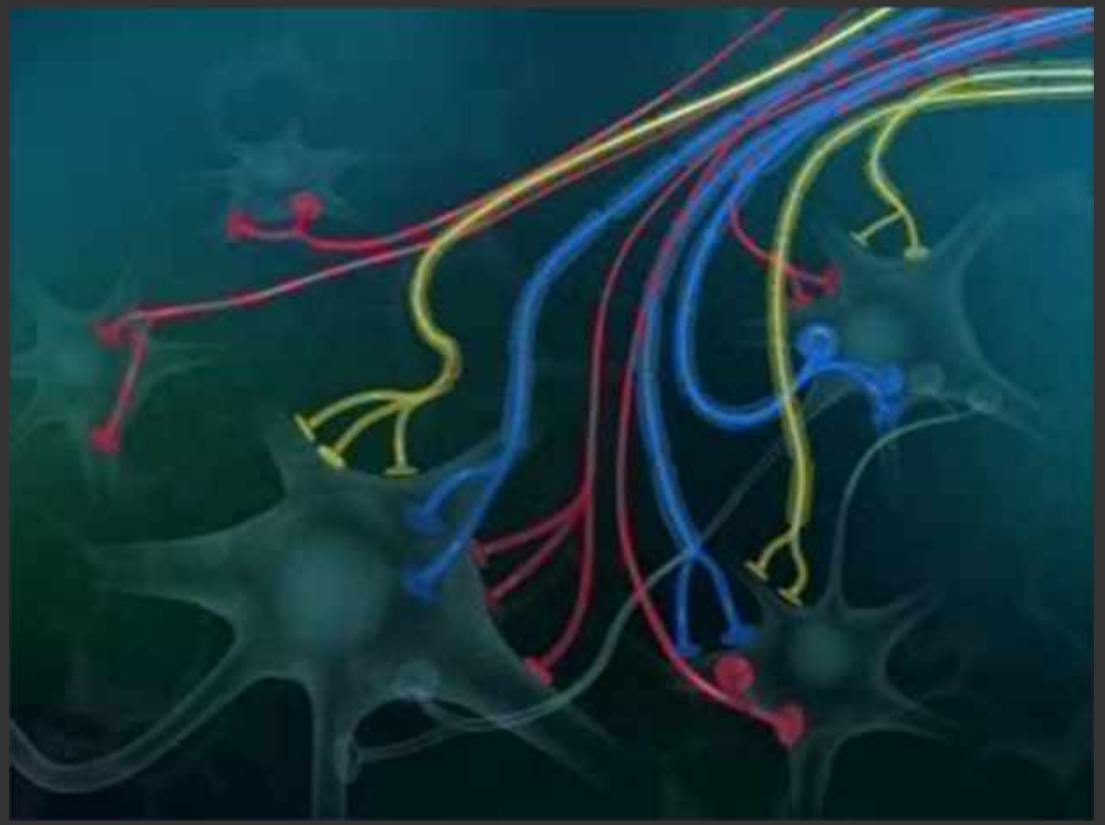
Neurophysiologic Determinants of Central Sensitization

Enhanced *Input:Response* Profile at Synapse



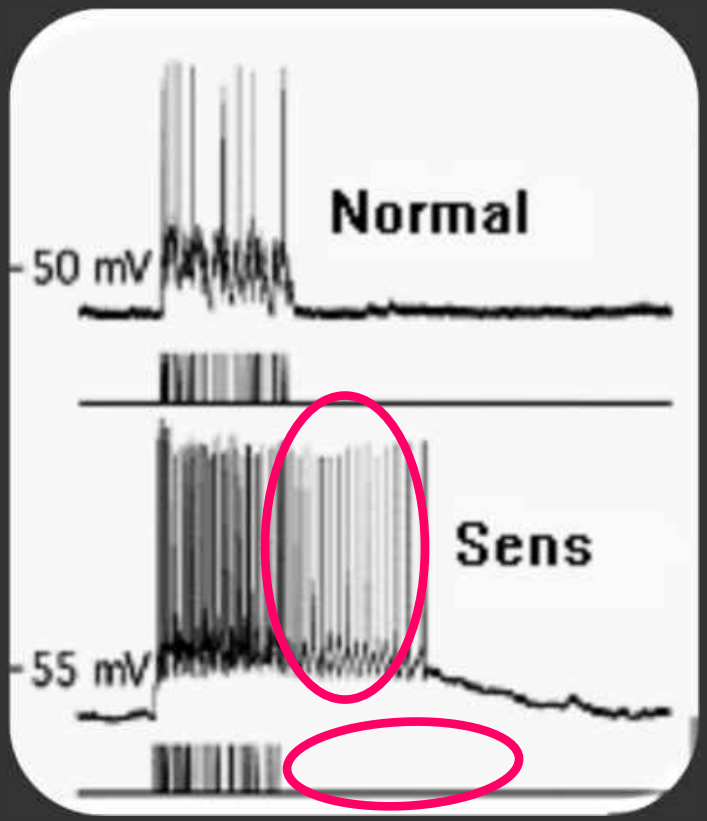
Derjean, 2003

- Increased frequency response of post-synaptic neuron



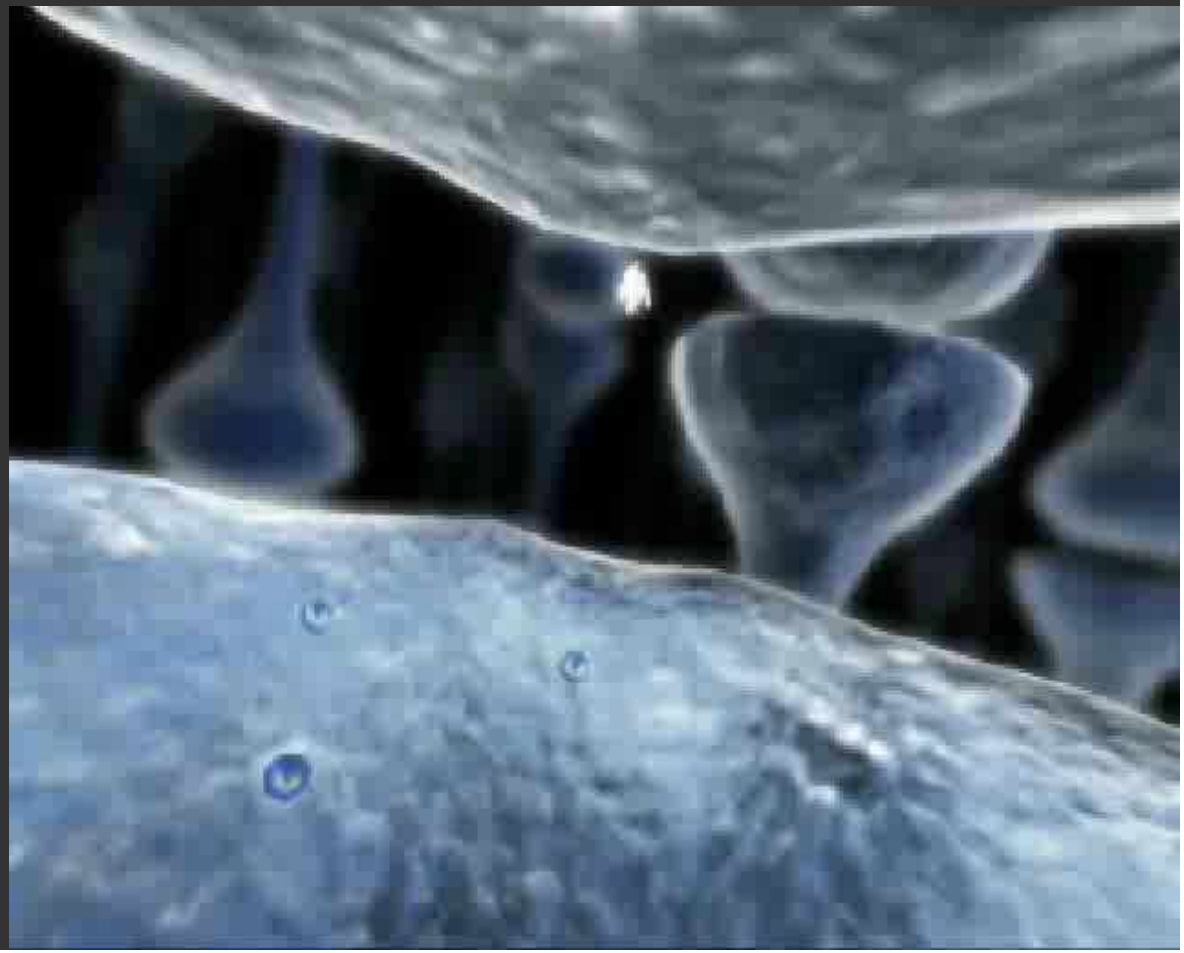
Neurophysiologic Determinants of Central Sensitization

Enhanced *Input:Response* Profile at Synapse



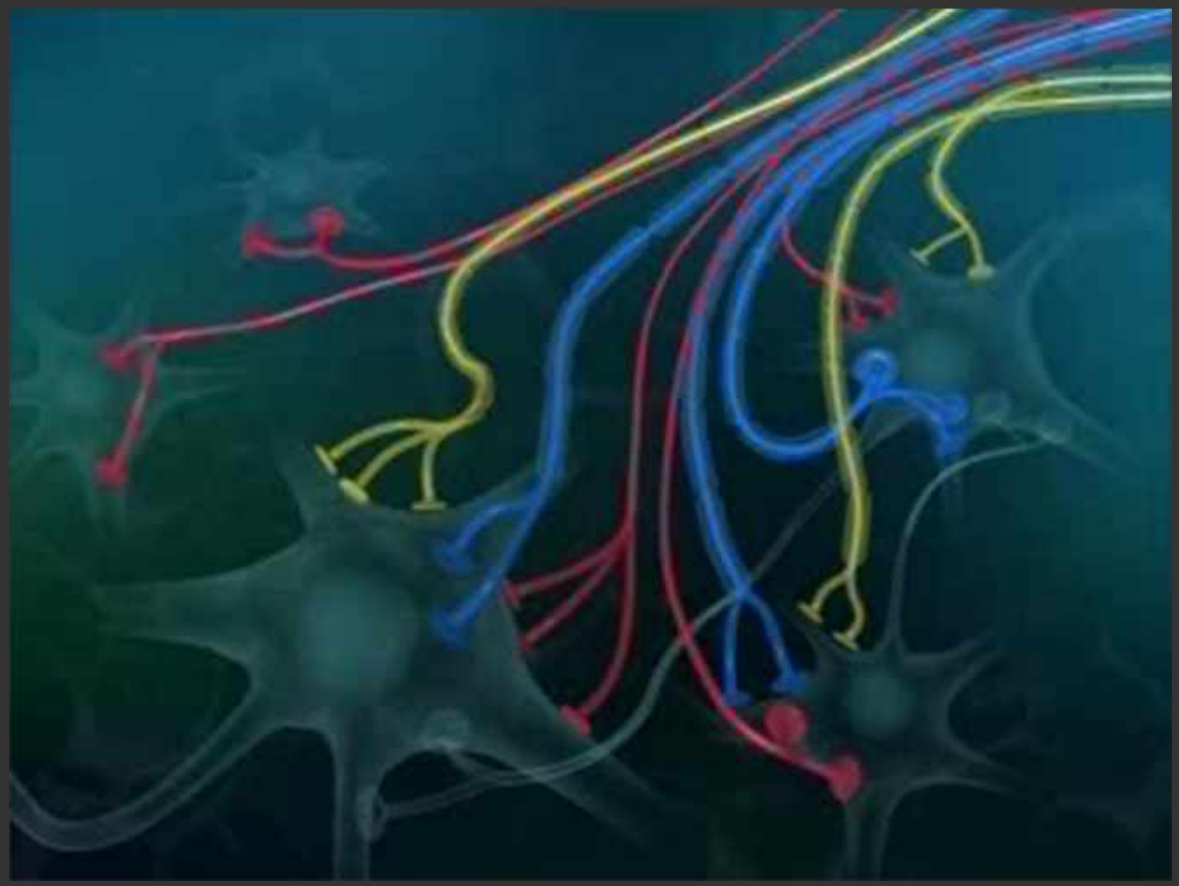
Derjean, 2003

- Frequency response continues after removal of input stimulus



Active MTrPs and Central Sensitization

Wide Dynamic Range Neuron



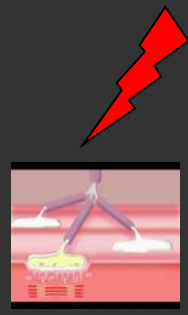
Clinical Hallmarks of Central Sensitization:

1) Allodynia
2) Hyperalgesia
3)Expansion of the Receptive Field of Pain
4)Pain with Muscle Movement

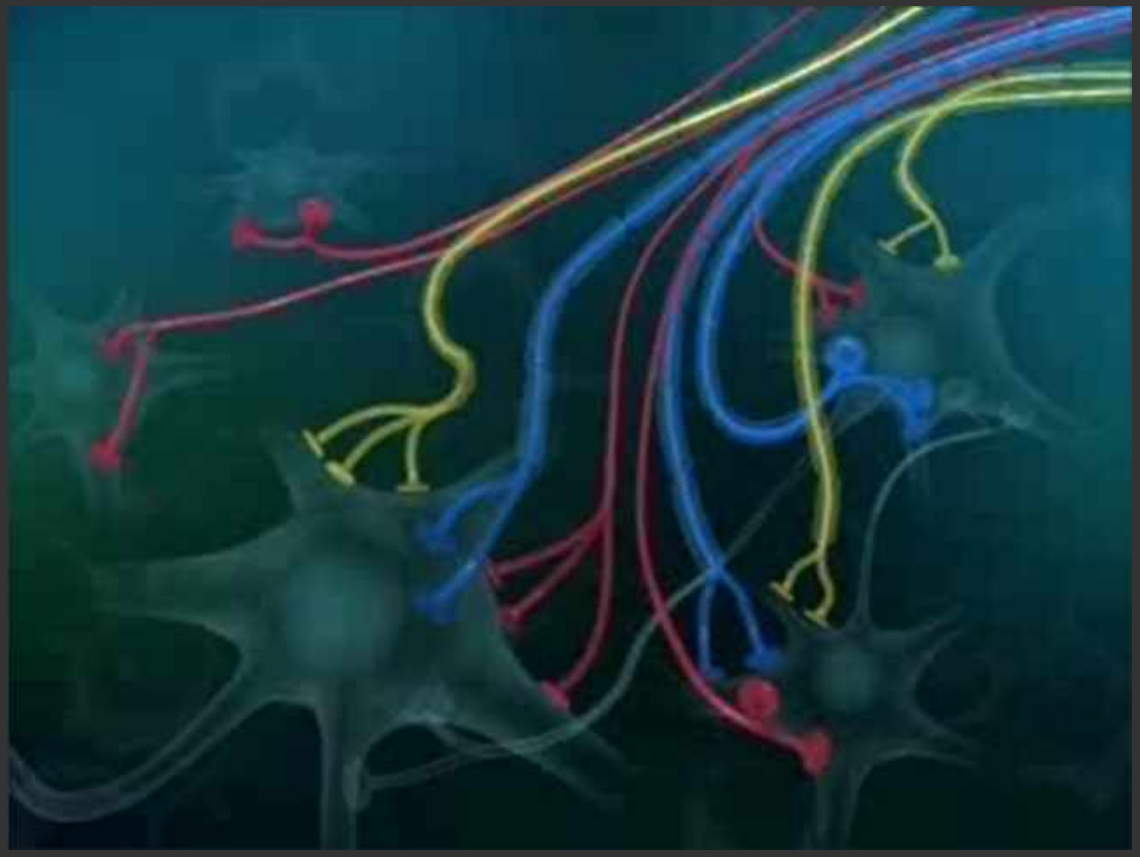
Prolonged Activation of Wide Dynamic Range Neurons

Central Sensitization, Dysfunction or loss of Inhibitory Neurons and

Creation of Facilitated Segments

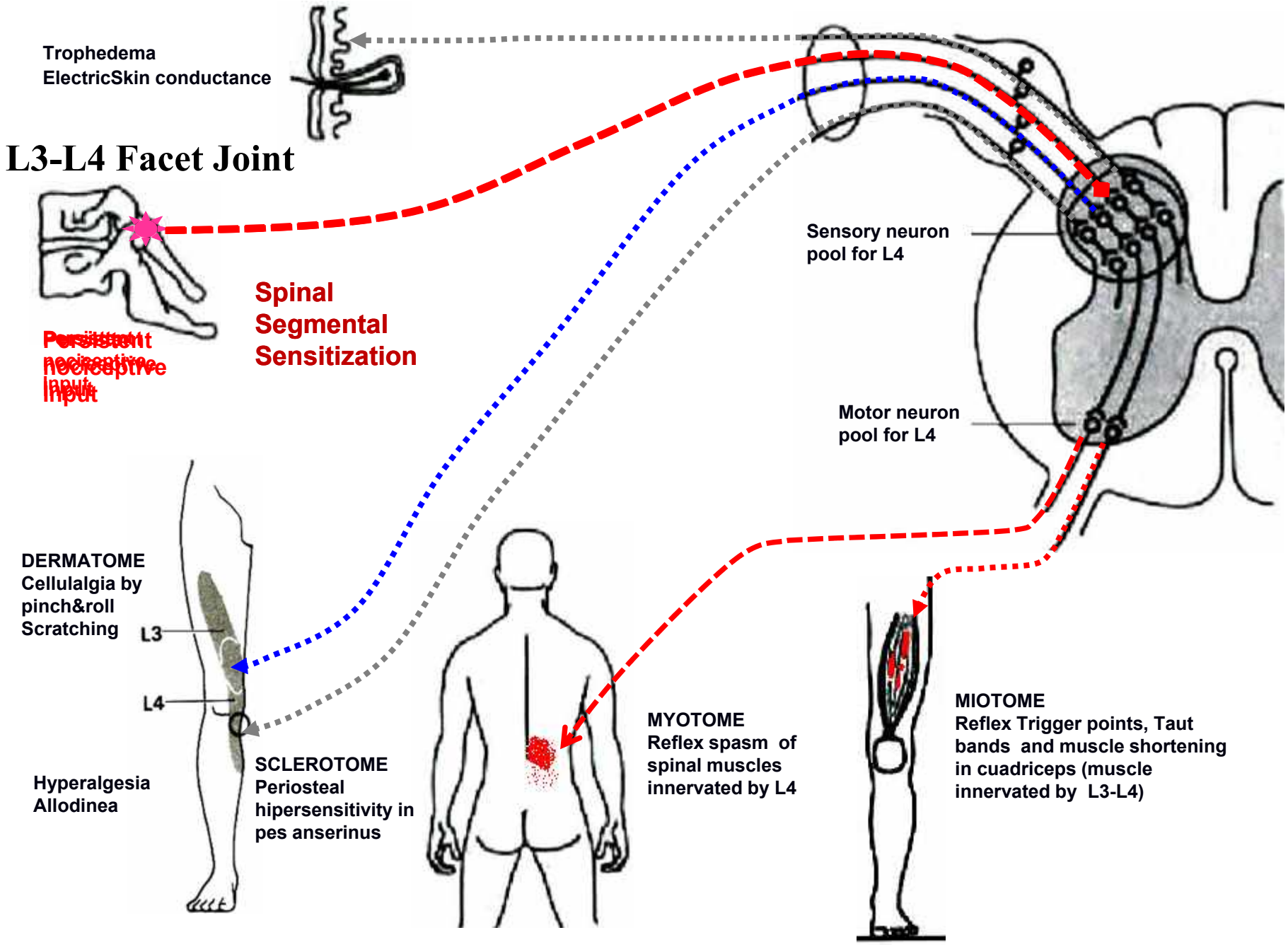


Wide Dynamic Range Neuron

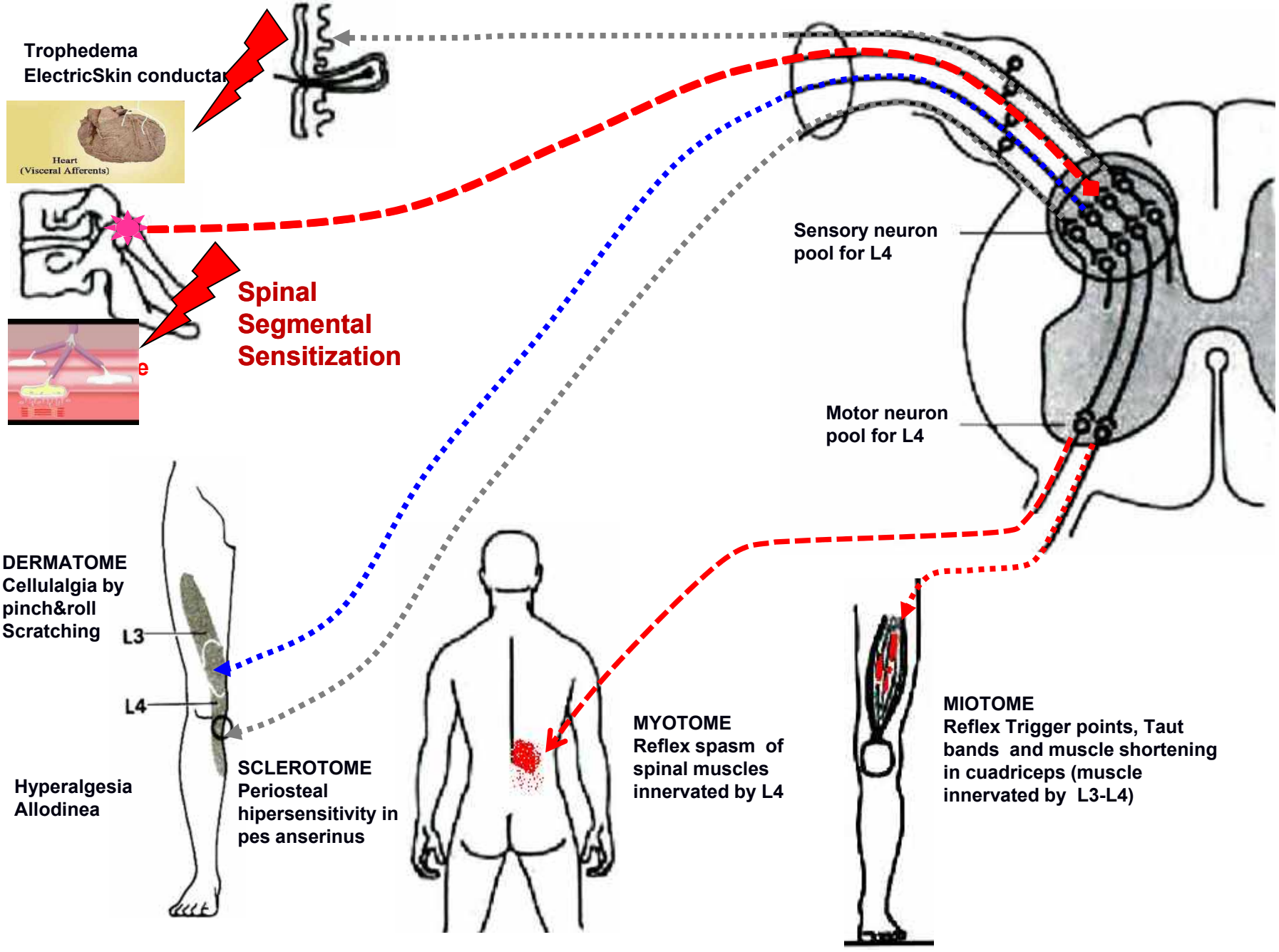


Activity-Dependent Neuroplasticity

FACILITATED SEGMENT AND SPINAL SEGMENTAL SENSITIZATION



FACILITATED SEGMENT AND SPINAL SEGMENTAL SENSITIZATION

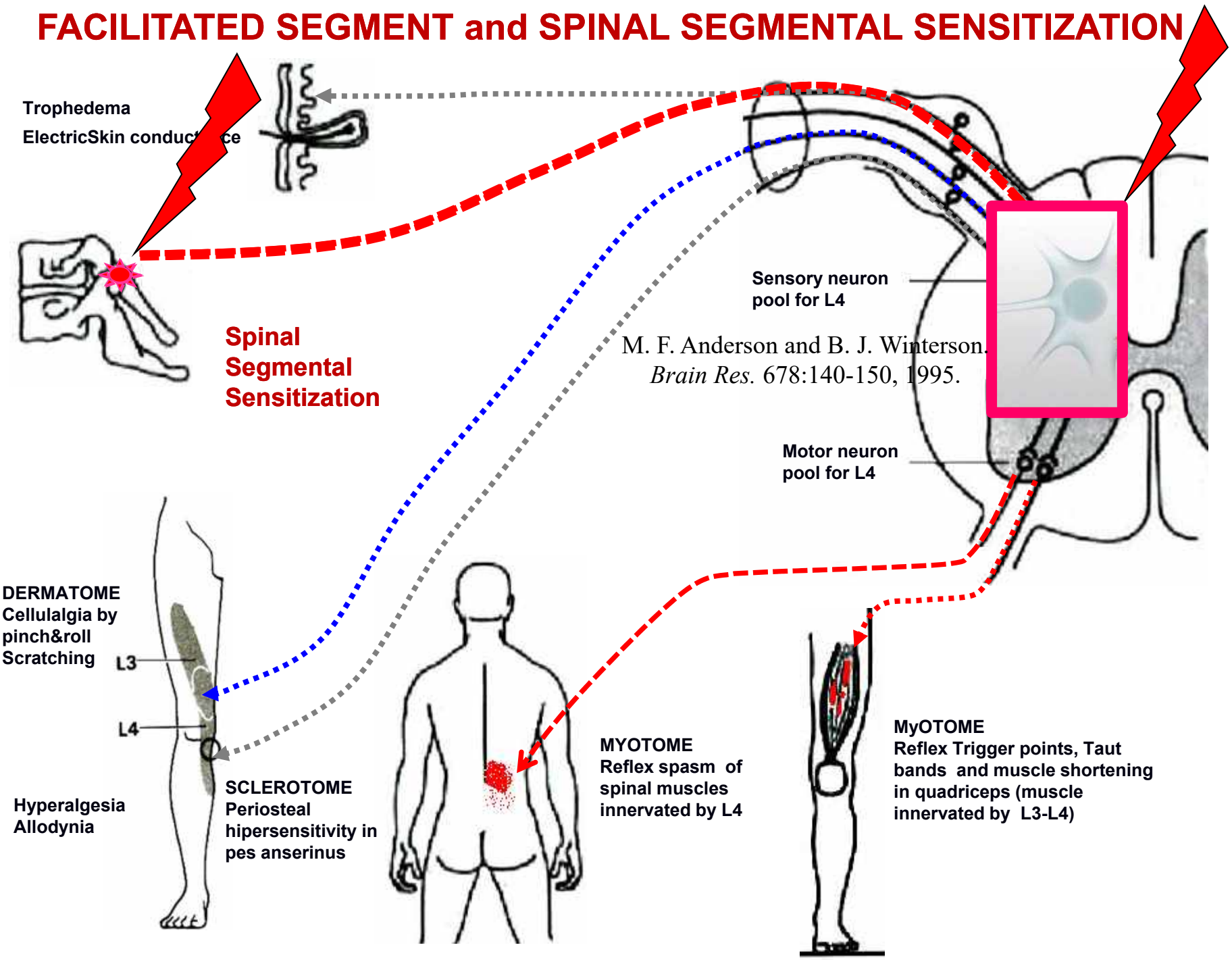


NEUROGENIC HYPOTHESIS
CHRONIC MYOFASCIAL PAIN

Chronic myofascial pain is the clinical manifestation of *neurogenic inflammation* (subsequent to central sensitization) evoked by nociceptive inputs arising from a *distinct primary pathology* within the common neurosegmental field of the affected muscle.

Srbely 2010

FACILITATED SEGMENT and SPINAL SEGMENTAL SENSITIZATION

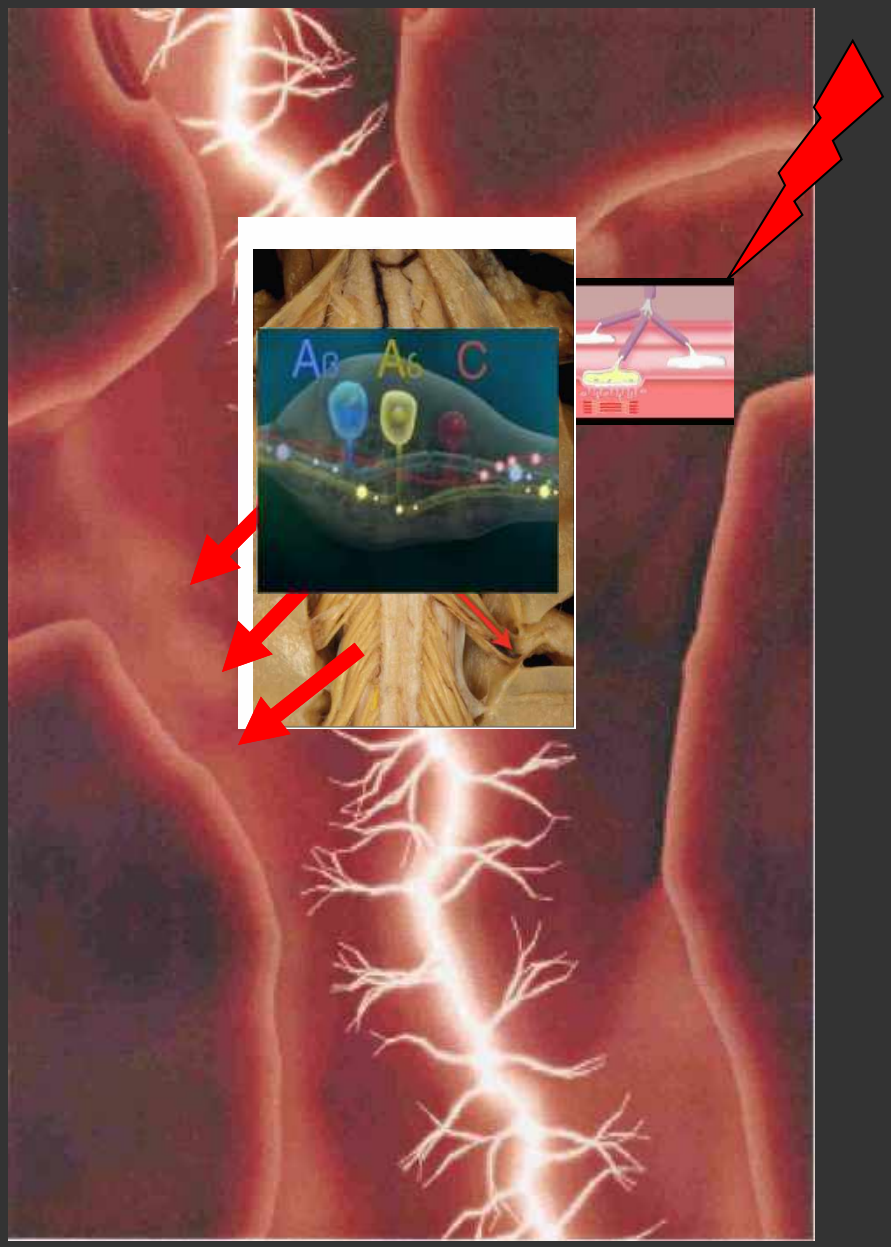


Central sensitization and LTP: do pain and memory share similar mechanisms?

Ru-Rong Ji[1], Tatsuro Kohno[1], Kimberly A. Moore[2] and Clifford J. Woolf[1]

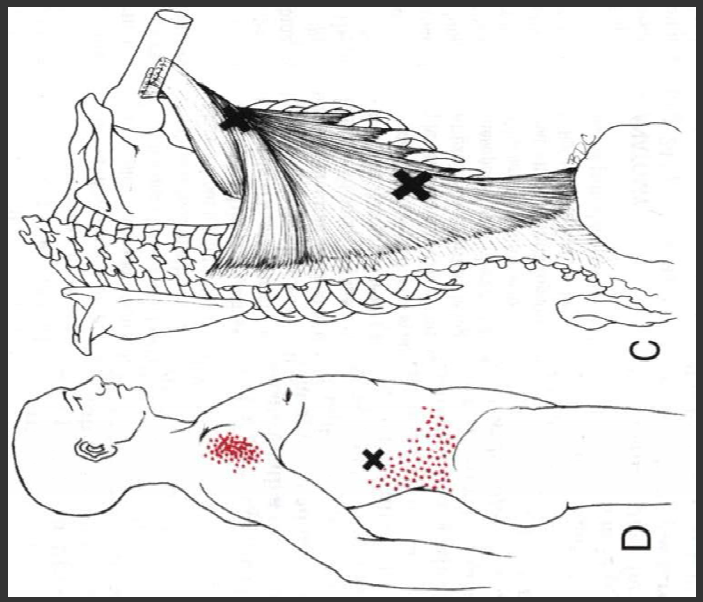
[1]Neural Plasticity Research Group, Department of Anesthesia and Critical Care, Massachusetts General Hospital and Harvard Medical School, Boston, MA 02129, USA
[2]Department of Cellular and Molecular Pharmacology, University of California San Francisco, San Francisco, CA 94143, USA

Active MTrP Bomardment *Sensitizes* the Spinal Segment, Resulting in Expansion of the Receptive Field of Pain



Zimmermann, Sem Arth. Rheu. 18:22, 1989

Latissimus dorsi (C6-C8)



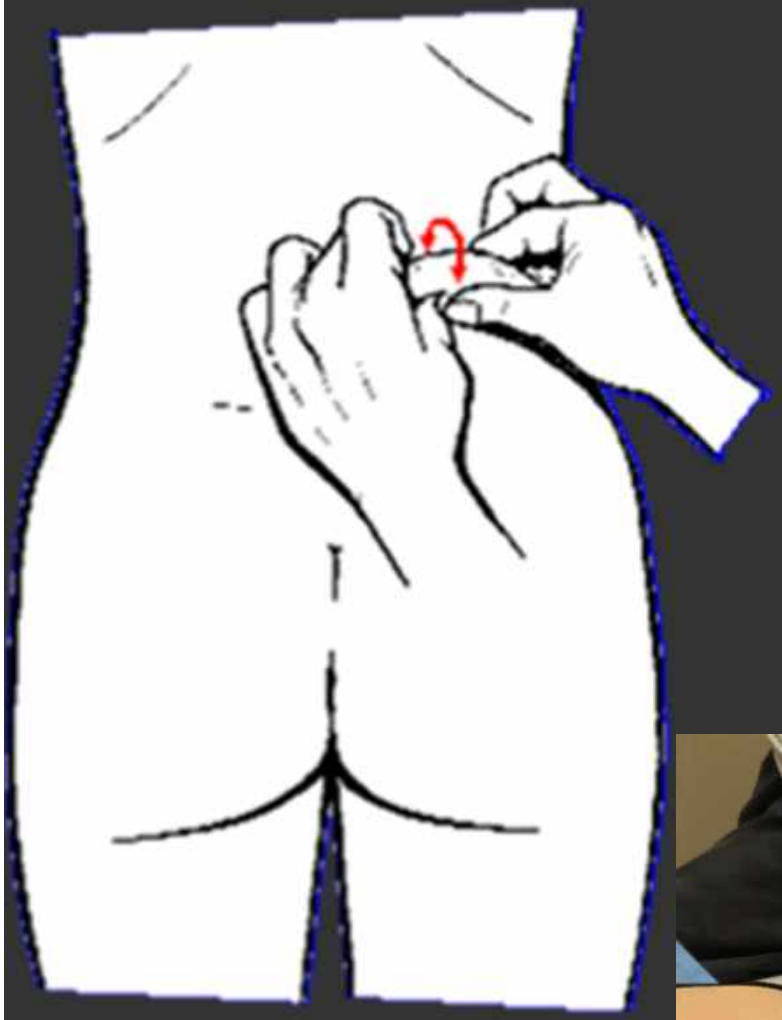
Manifestations of Central Sensitization:

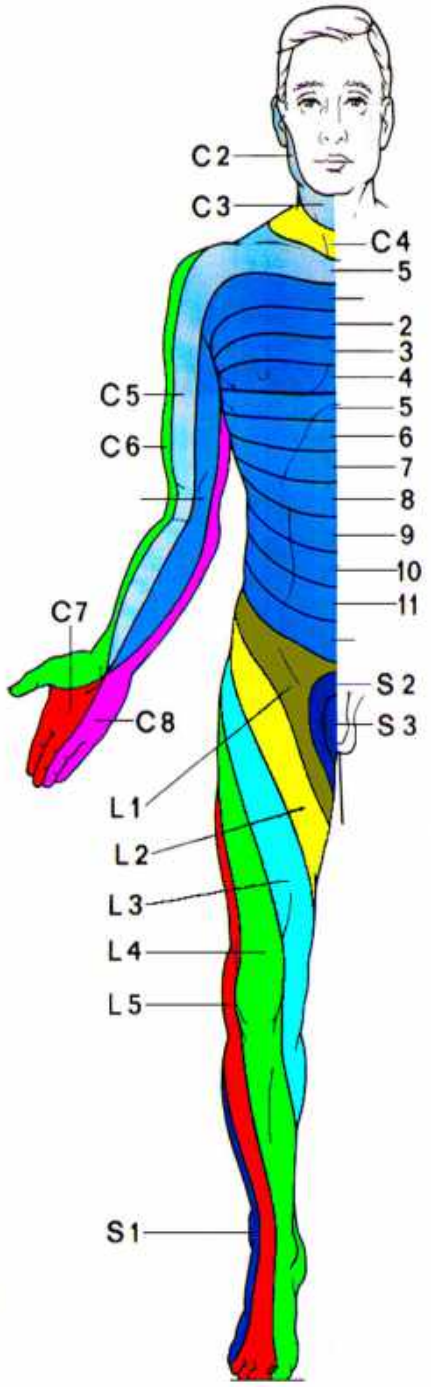
Allodynia, Hyperalgesia, and Expansion of the Receptive Field of Pain

Spinal Segmental Sensitization:

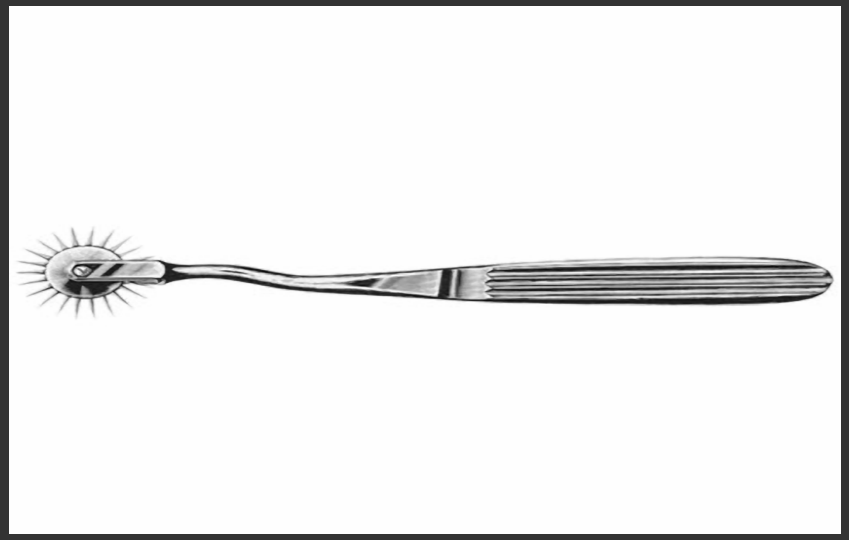
Segmental Allodynia and Hyperalgesia

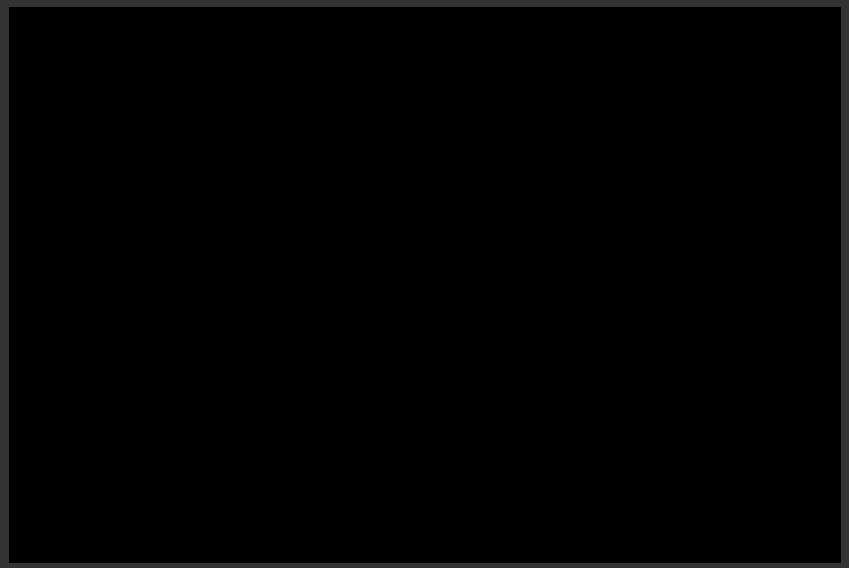
PINCH & ROLL: Allodynia

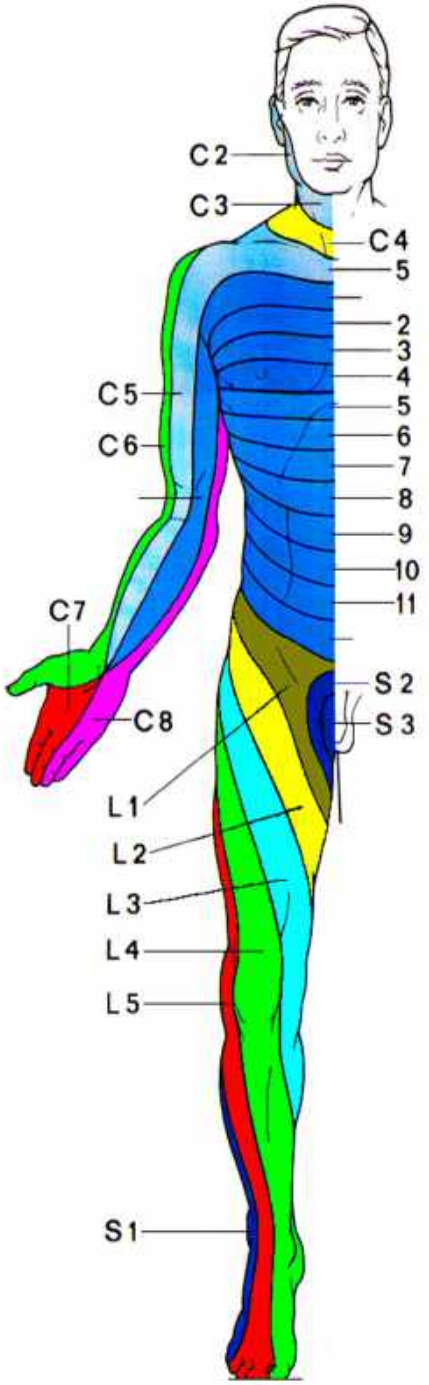




Waternberg Pinwheel: Hyperalgesia





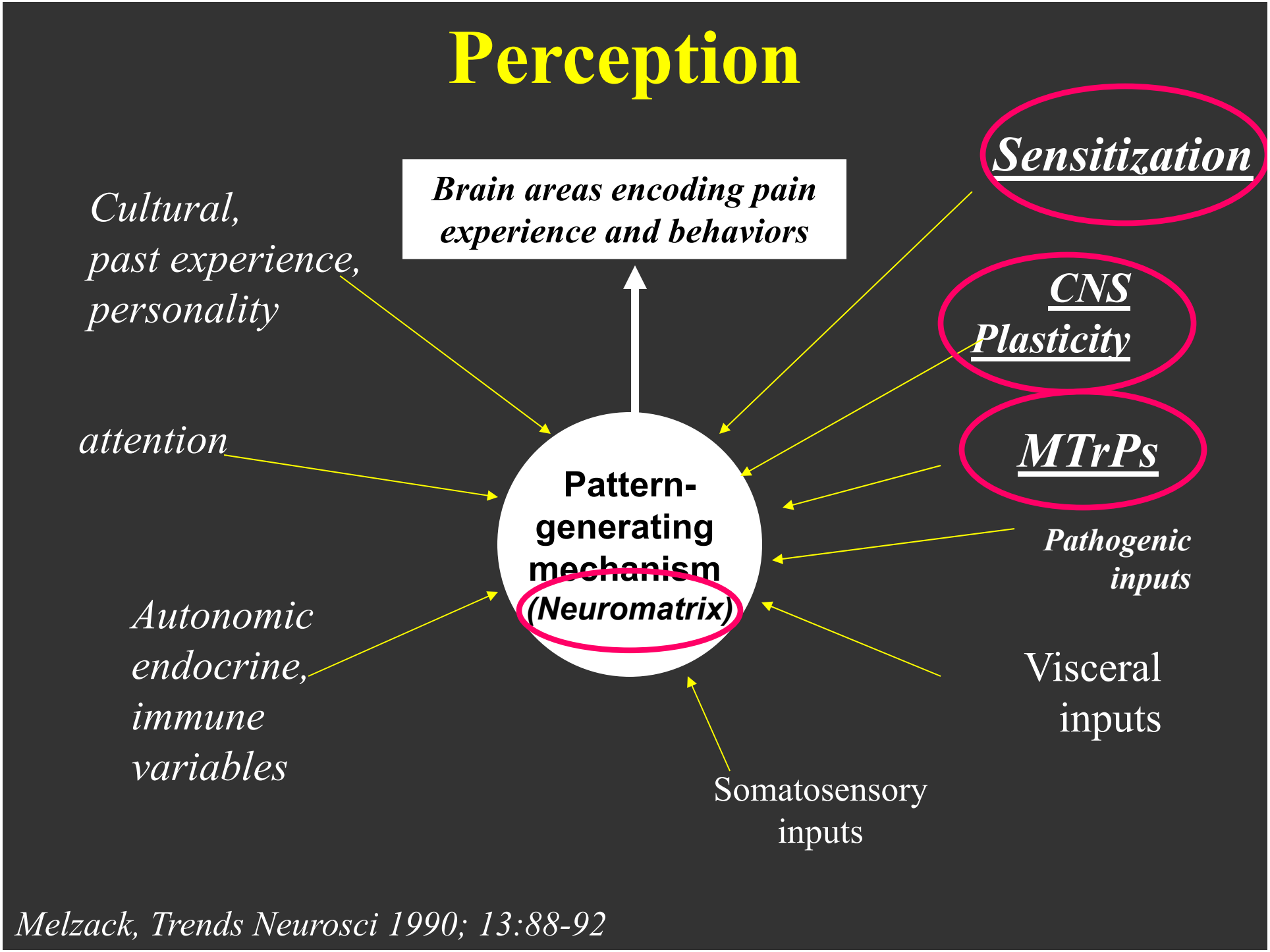


Of course, in some people it's very easy to palpate the soft tissue…

Chronic Pain and and Spinal Segmental Sensitization

"The future of pain management will require the development of diagnostic methods that permit us to identify the mechanisms of pain in an individual patient and treatments that target those mechanisms." Woolf et. al. *J Pain*. 2016; 17(9)

Perception



Melzack, Trends Neurosci 1990; 13:88-92

Perception

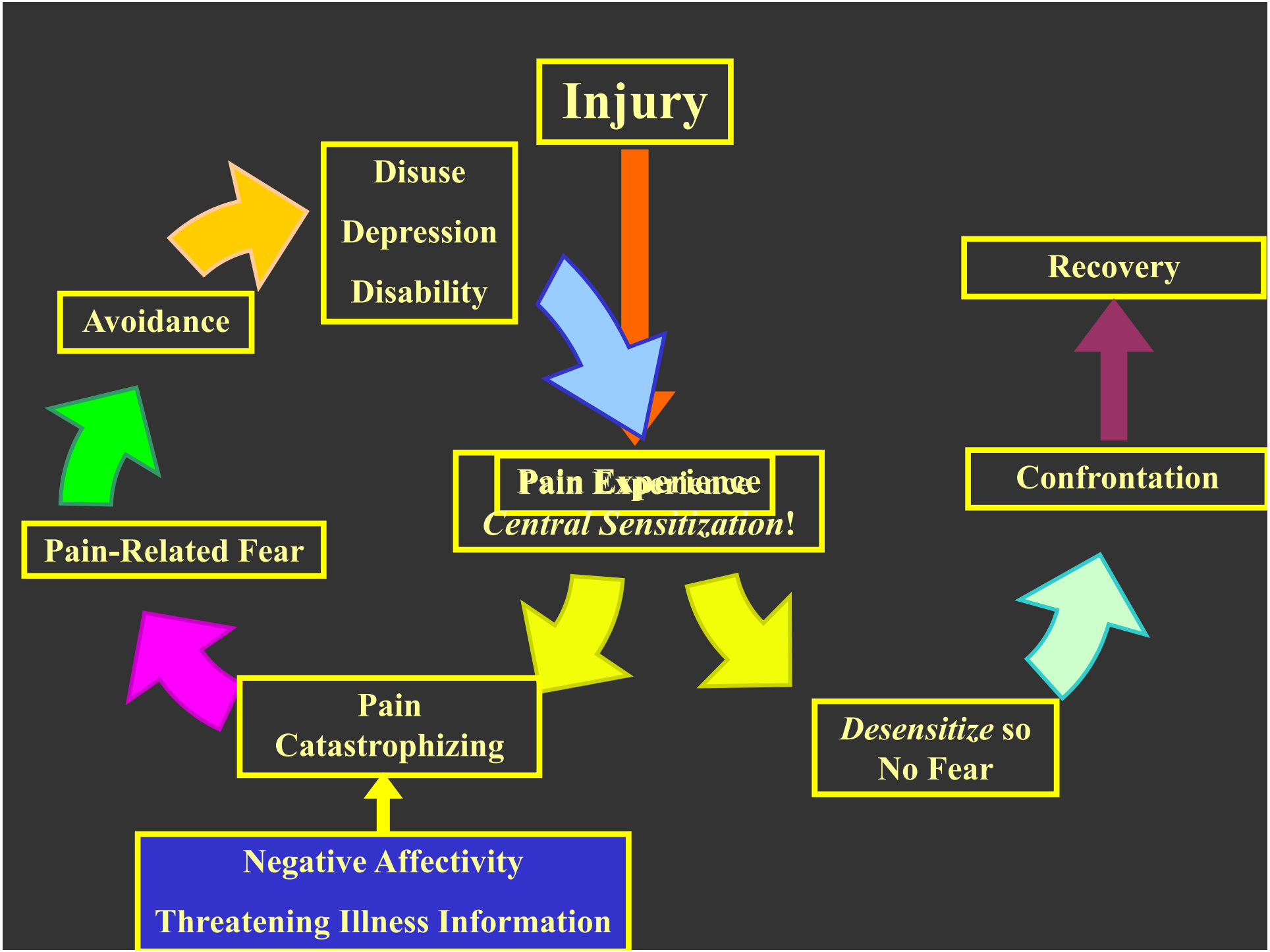
- "Perception of pain is thus generated by the output of the neuromatrix as a function of sensory inputs that feed into it, together with information from the regions of the brain involved in affective and cognitive activities."
- "Pain behaviors can be generated or perpetuated by previously conditioned cues in the environment or by the expectation of pain and suffering."
- "The output of the neuromatrix can be modified by various forms of treatment that change the inputs, or influence the neuromatrix"
- "Neuronal plasticity" is memory of pain – in 1999, IASP revised definition of chronic pain adding "…the memory of pain can be more damaging than its initial experience" (i.e., PAIN KILLS)

Melzack, Trends Neurosci 1990; 13:88-92

Chronic Pain and Suffering: A Unique Perceptual Experience

Mal-Adaptive Neuroplasticity

Can we identify the pain mechanism(s)?


Injury
Disuse
Depression
Disability
Avoidance
Pain-Related Fear
Pain Experience
Central Sensitization!
Pain
Catastrophizing
Negative Affectivity
Threatening Illness Information
Desensitize so
No Fear
Confrontation
Recovery

Question

Which of the following are characteristic of a active myofascial trigger point?

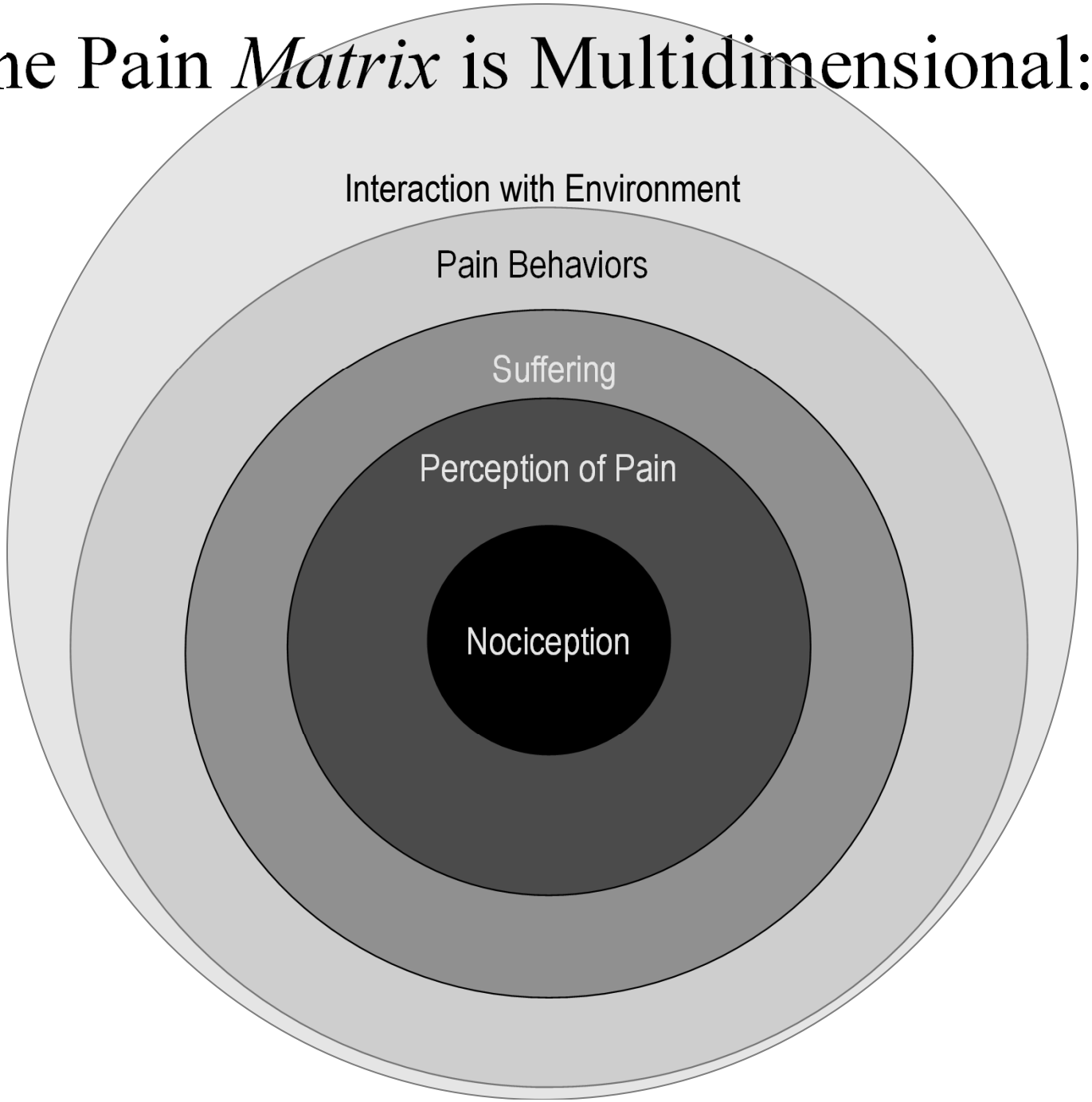
A. Associated with spontaneous pain

B. A hyper-irritable nodule in a taut band of muscle

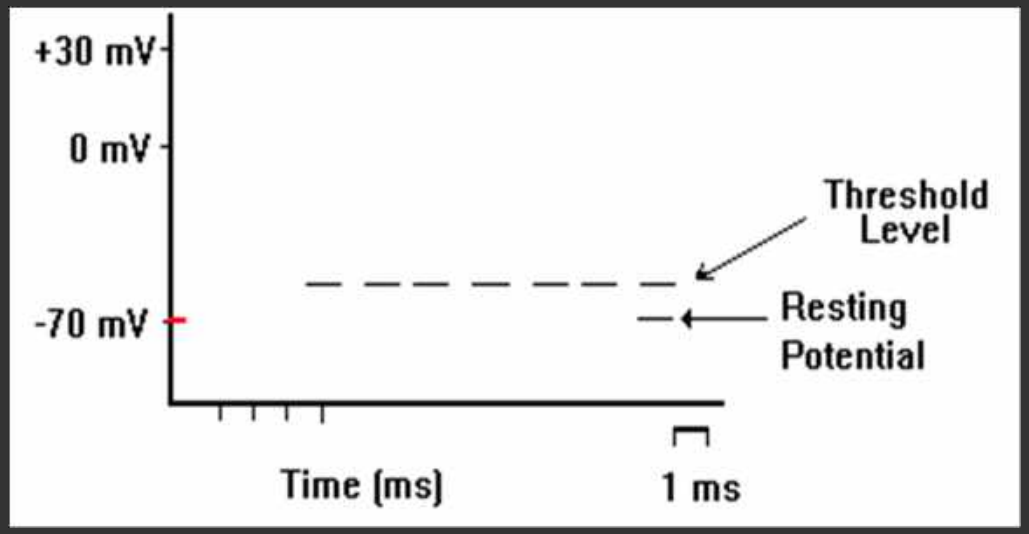
C. Produces local and often referred pain

D. All of the above

The Pain *Matrix* is Multidimensional:



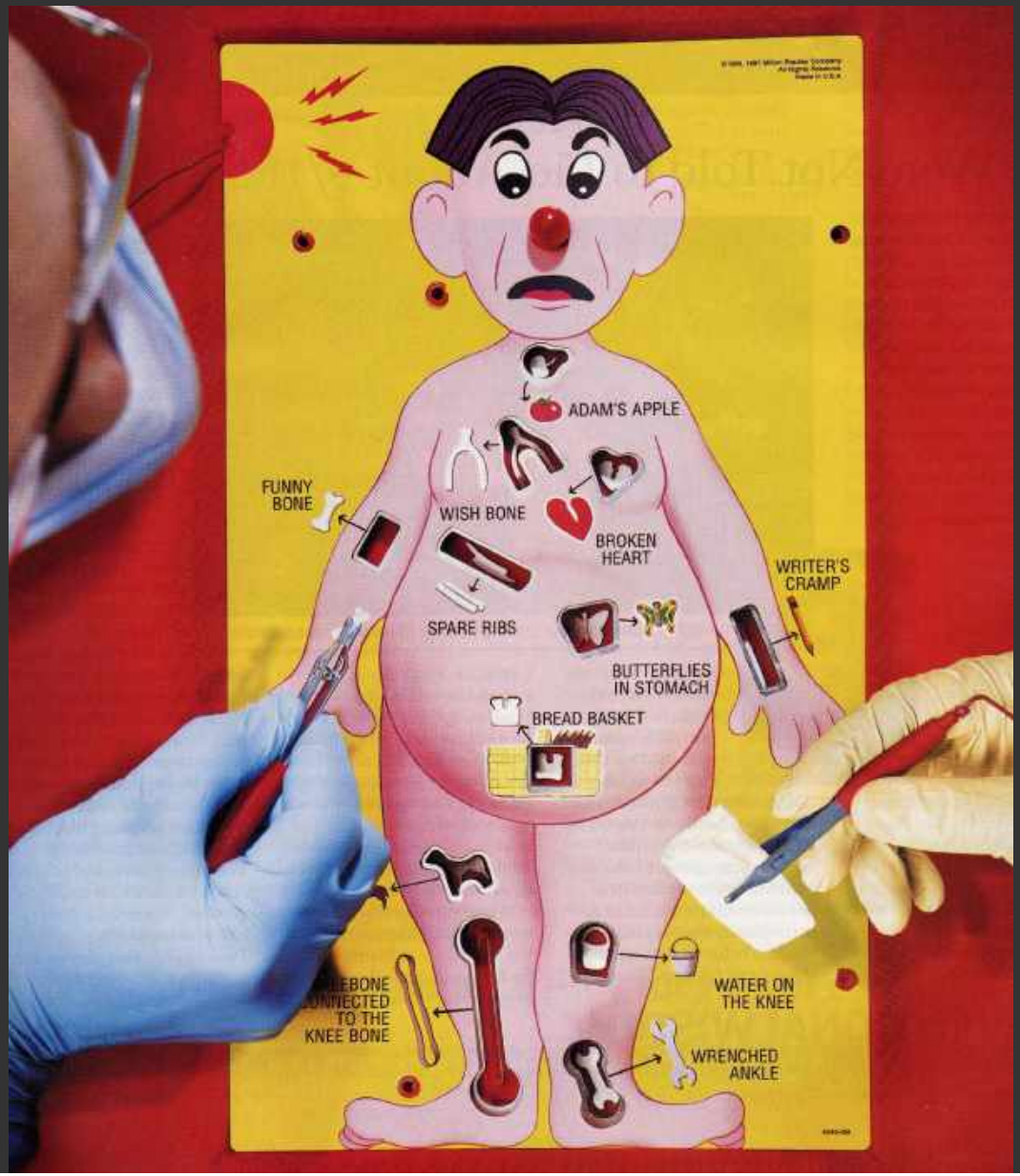
How does Nociception Differ from Pain?



Traditional Categorization of Pain States

- Time (e.g., acute/chronic)
- Causative factors (e.g., Whiplash, Repetitive Strain Injury, Cumulative Trauma Disorder, etc.)
- Body part (e.g., lateral elbow pain, headache, etc.)

Medical Model of Pain

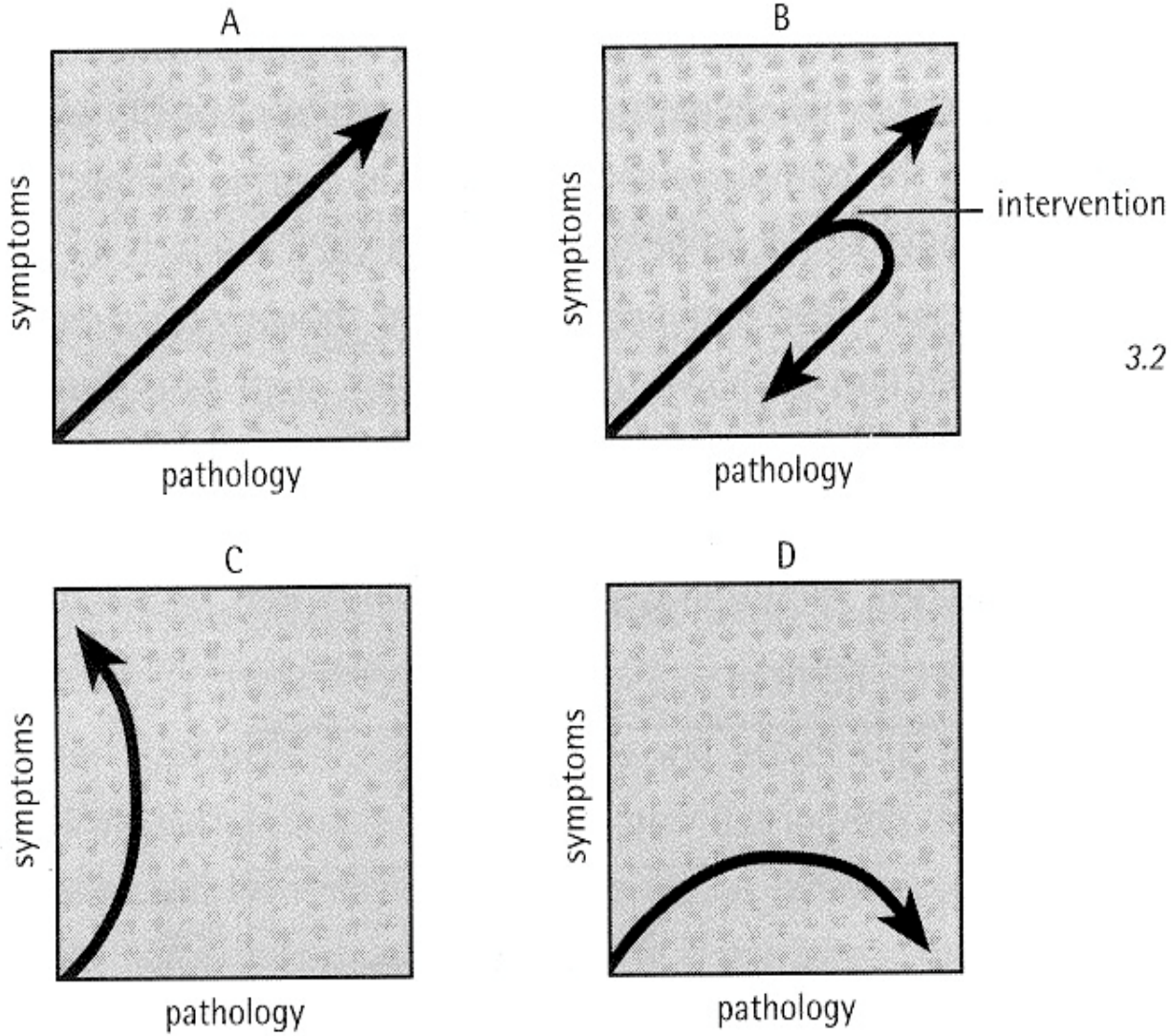


This Model Does Not…

1) predict outcome
2) give guidance to treatment
3) allow a search for risk factors
4) identify subcategories which may be responsive to certain therapies

Butler, D. The Sensitive Nervous System. 2000.

Medical Model of Pain



3.2 *Variations in the relationship between symptoms and known pathology.*

A represents the medical model where pathology and symptoms match.

B is the expected result from intervention.

C is the typical clinical finding in chronic pain - lots of symptoms but where is the pathology?

D represents the common finding in society where pathological changes are extremely common yet are not necessarily associated with pain (adapted from Haldeman 1990).

Butler, D. The Sensitive Nervous System. 2000.

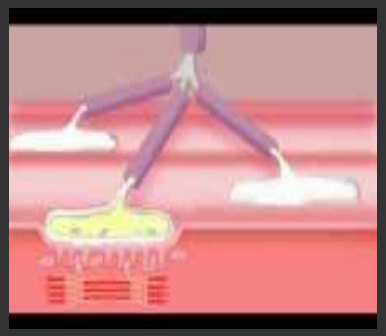
An Expanded Conceptual Model for Understanding Pain States

- Pain should be characterized in terms of its mechanisms or processes, and thus essentially its biochemistry
- A comprehensive model of all pain states must include peripheral and central factors
- Pain mechanisms are not diseases or specific injuries; they simply represent a process or biologic state

Woolf C, Decosterd I. Implications of recent advances in the understanding of pain pathophysiology for the assessmentof pain in patients. *Pain* 1999;Suppl 6:S141-7..

Myofascial Conundrum

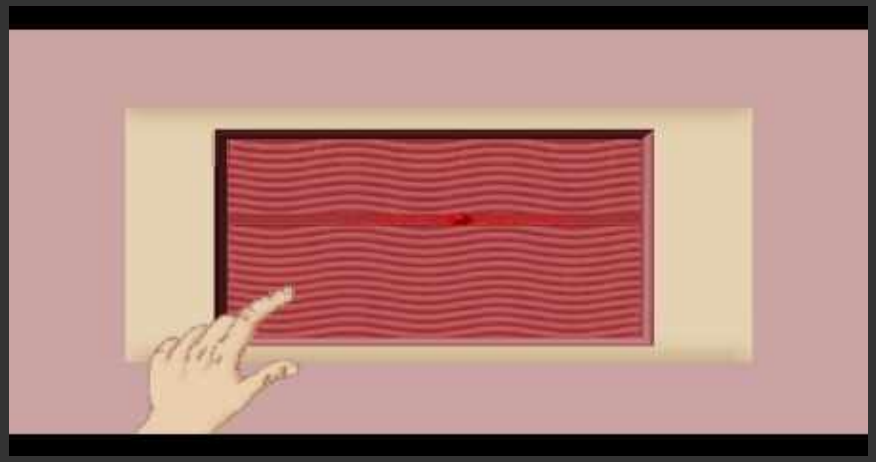
- Myofascial trigger points (MTrPs) are a very common, complex and *overlooked cause* of non-articular musculoskeletal pain whose pathophysiology is unknown
- *Why?* Because the diagnostic criteria are imprecise and the full impact of MPS on life activity and function is not fully understood
- Furthermore, there are currently no accepted criteria (e.g., biomarkers, electrodiagnostic, imaging, etc.) for diagnosing MTrPs or for assessing the clinical outcome of treatments



Hans-Werner
Weisskircher
www.trigger-point.com

Myofascial Pain and MTrPs: A Clinical Diagnosis

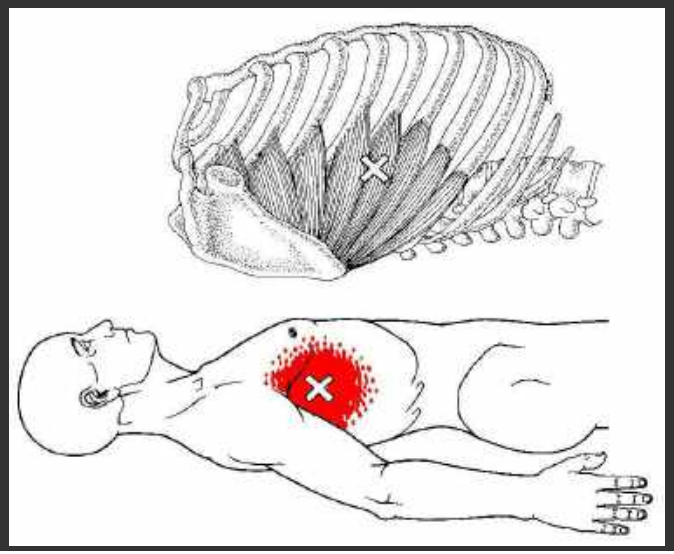
- **Palpation of a taut band**
- **Hard, palpable, exquisitely tender nodule (a myofascial trigger point) in the taut band**



Hans-Werner Weisskircher
www.trigger-point.com

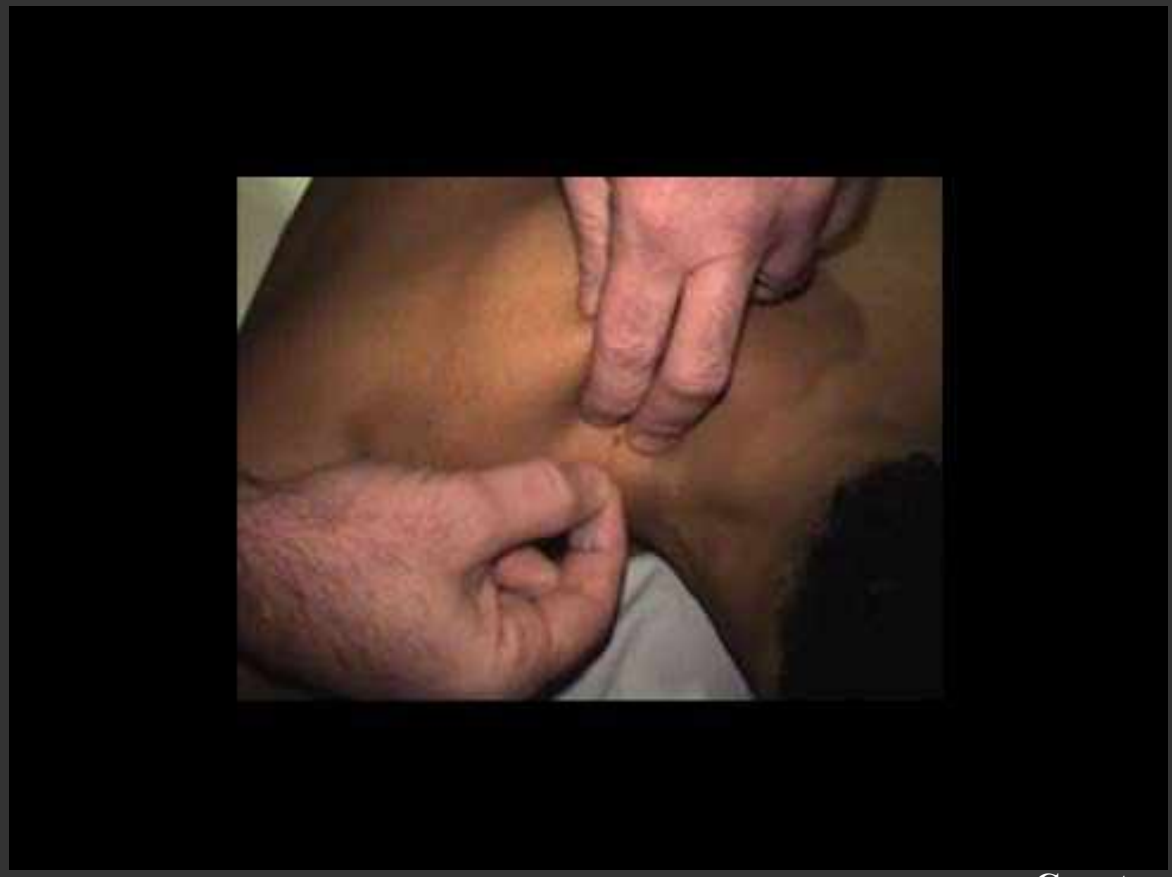
- **Reproduction of the person's symptomatic pain**

The Trigger Point Manual.
Simons, Travell and Simons,
1999

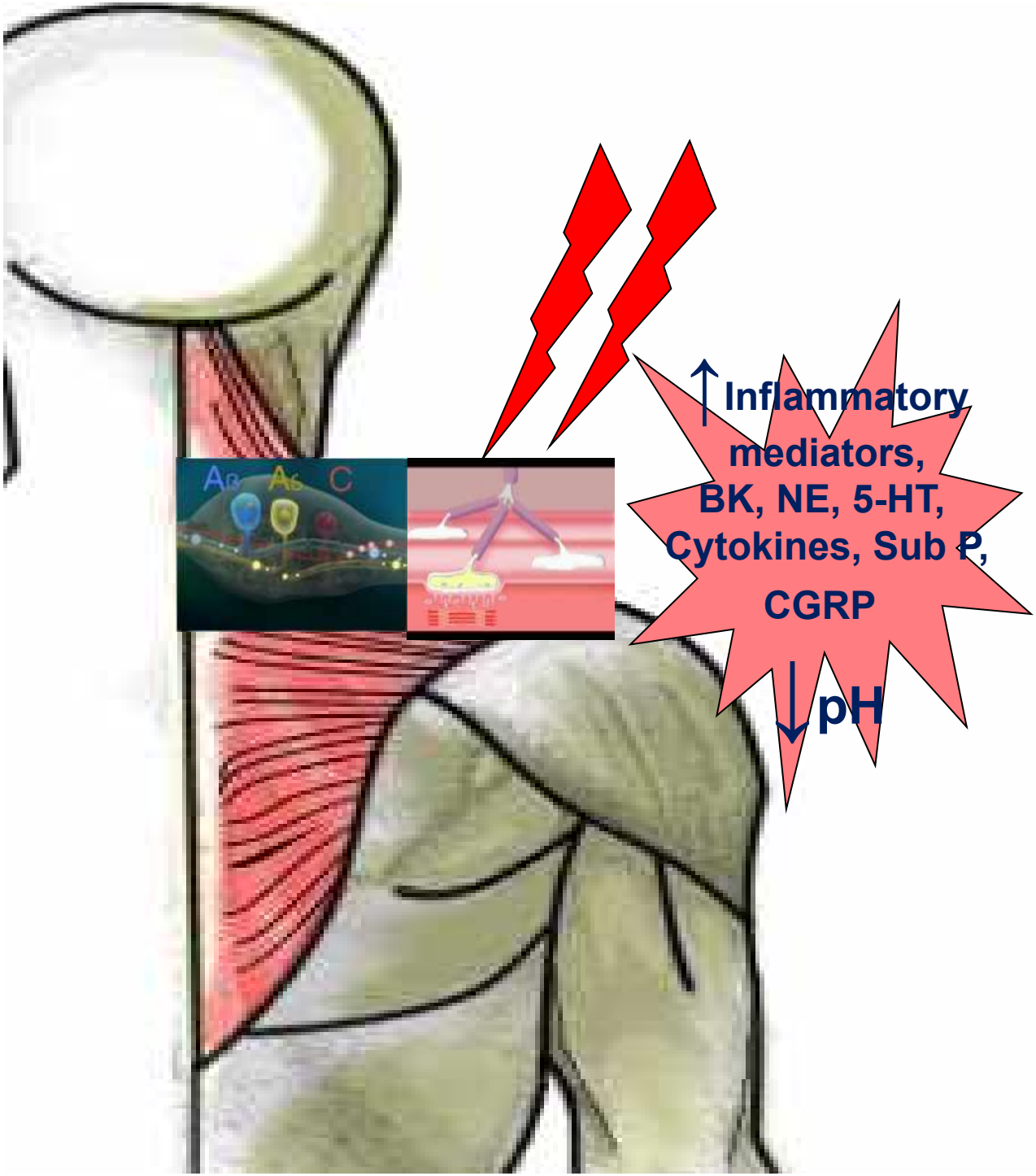


Trigger Point Injections and Dry Needling: Proper Technique to Elicit Local Twitch Responses is Essential

Hong CZ *Arch Phys Med Rehab* **1994;73:256**



Courtesy Joseph Audette, MD



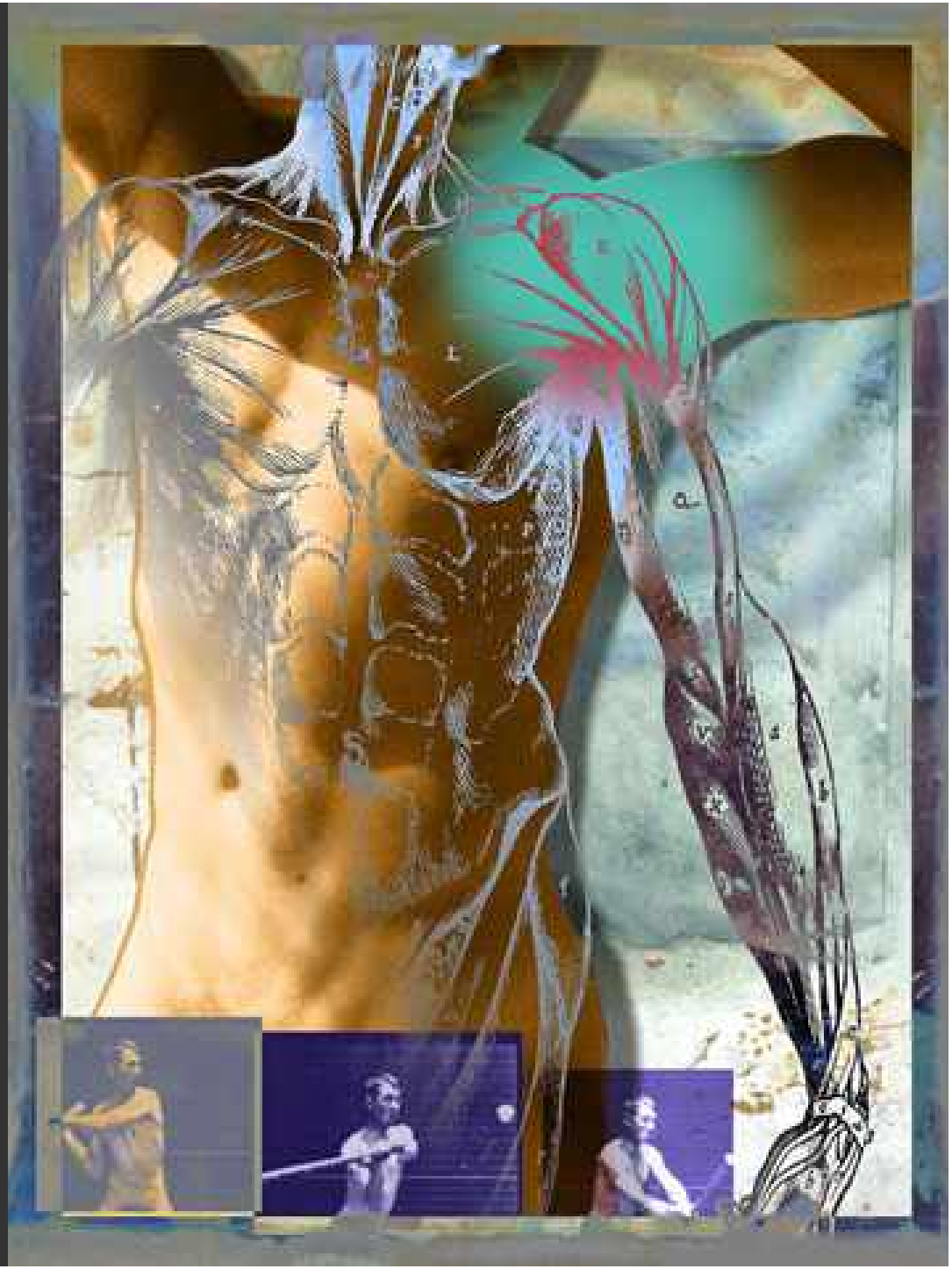
Sensitization: Hallmark in Transition from Acute to Chronic Pain

Can we identify the pain mechanism(s) in an individual patient?

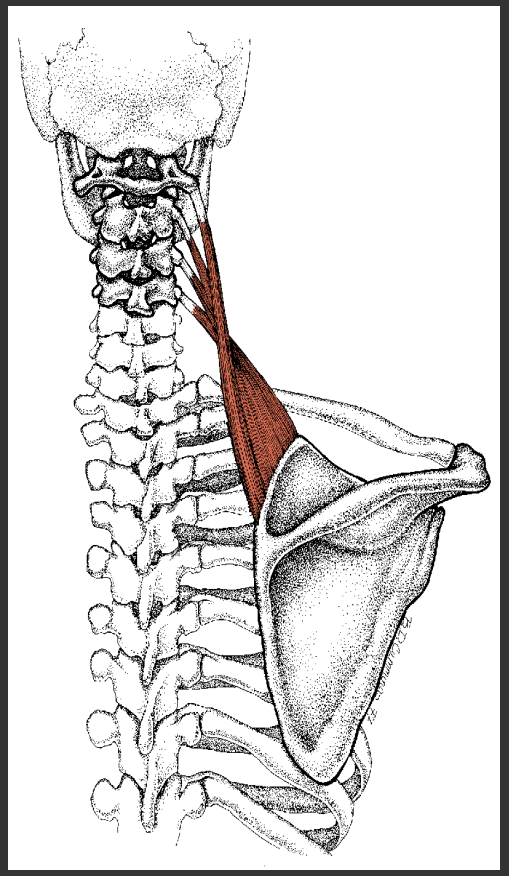
Technological Advancements:

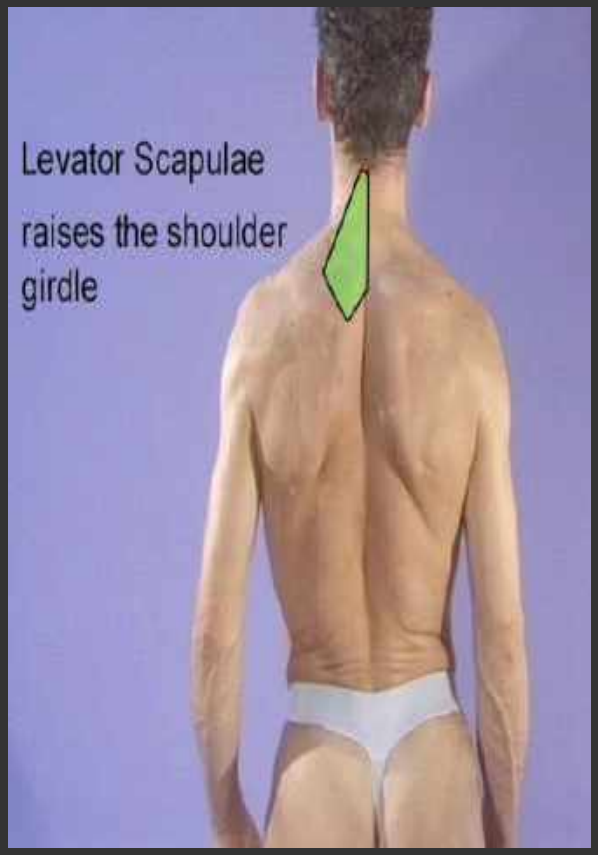
New and Abnormal Sodium Channels Migrate to Sites of Nerve Damage in Neuropathic Pain

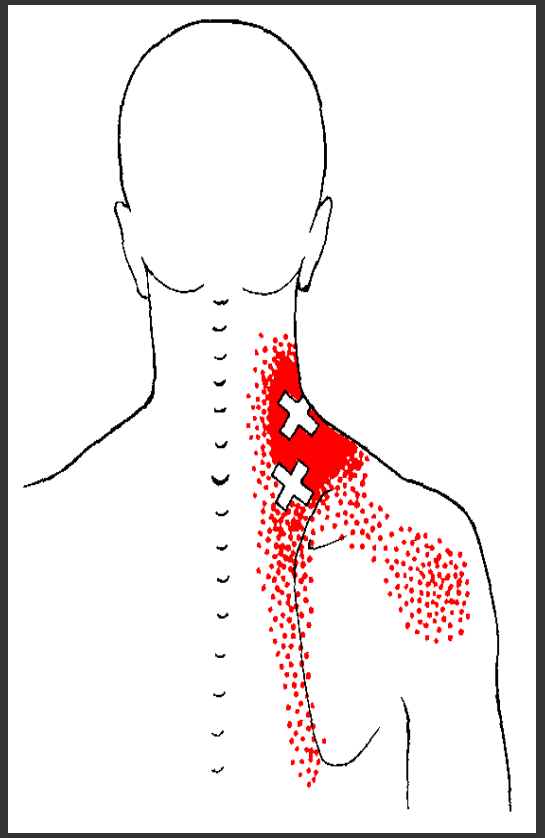
What about *Chronic* Musculoskeletal Pain?



Can we identify the pain mechanism(s) in *chronic* myofascial pain?







Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.

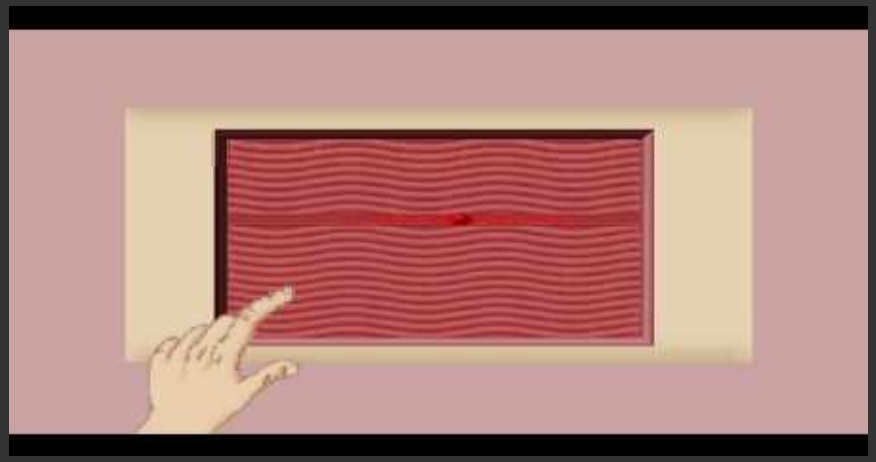
Common MTrPs in the Head, Neck and Shoulders and their Referral Patterns:

How to Palpate the Muscles

Rules for Diagnosing Myofascial Pain

The *Gold* Standard for Myofascial Pain:

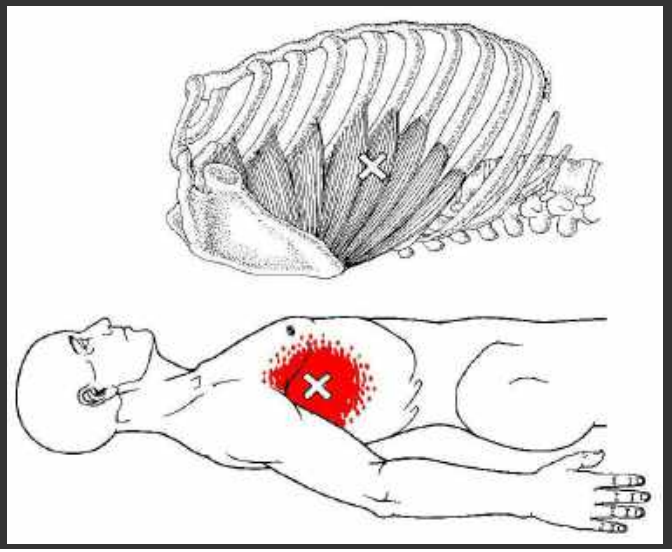
- **Palpation of a taut band**
- **Exquisitely tender nodule (a myofascial trigger point) in the taut band**



Hans-Werner Weisskircher
www.trigger-point.com

- **Reproduction of the person's symptomatic pain**

Courtesy Marta Imamura, MD

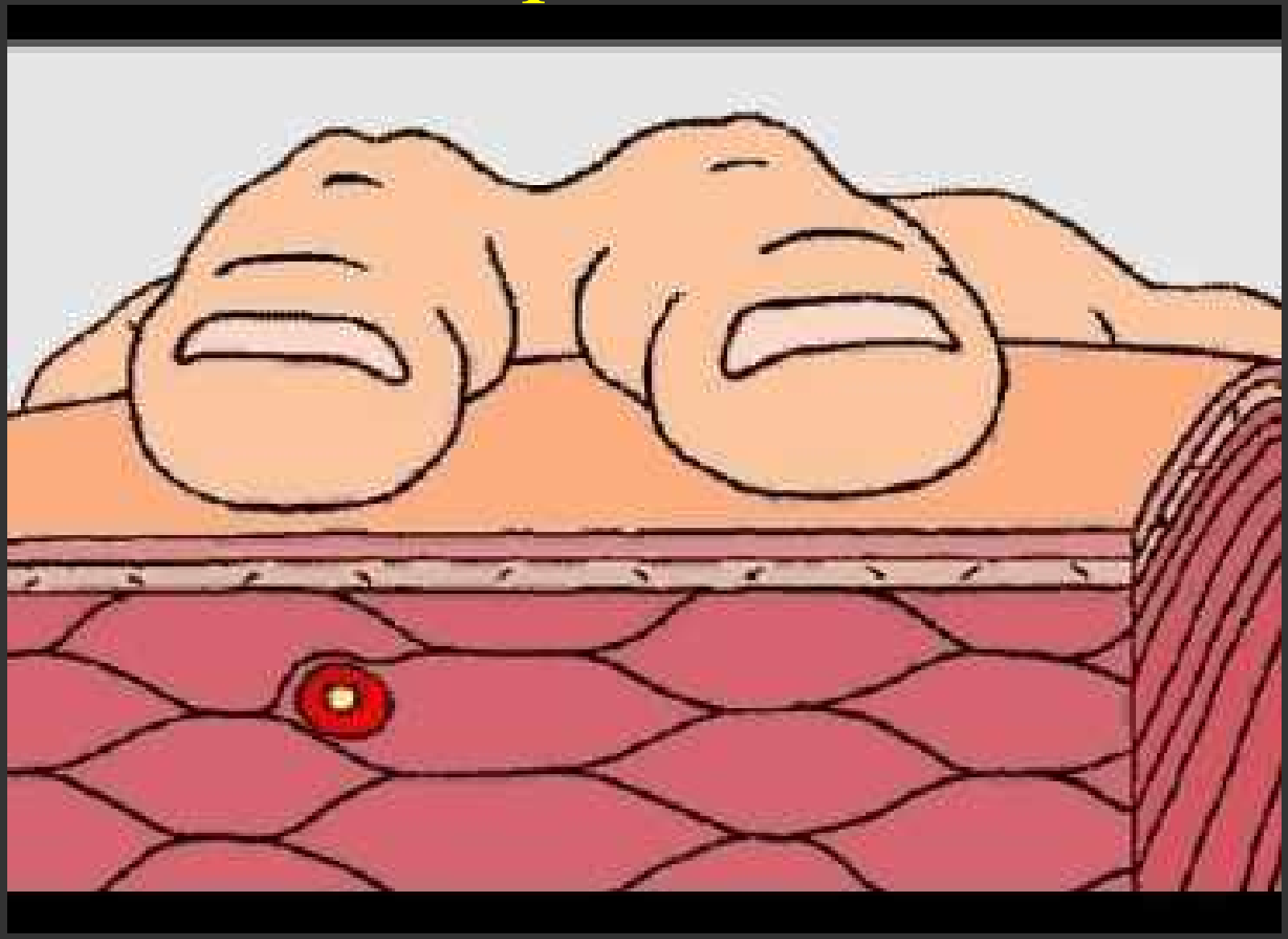


Palpation, Palpation, Palpation

- Careful palpation of the surface of the body reveals distinct differences in the quality and density of the underlying tissue. Many of these areas or points will be tender:

- A Shi points in Traditional Chinese Medicine
- Kori in Japanese system
- Muskelharten in German system

Hard, Palpable Nodules

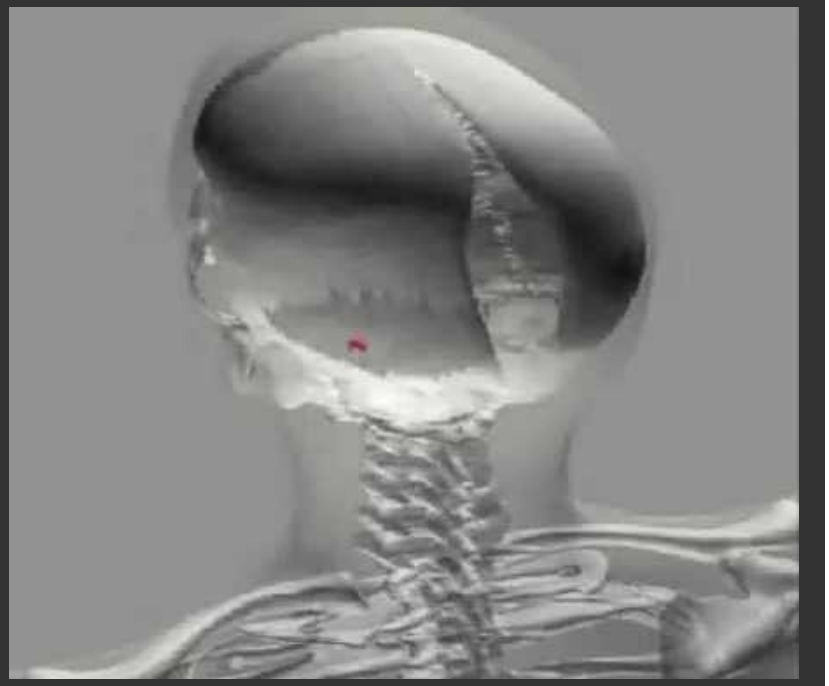


Hans-Werner Weisskircher www.trigger-point.com

Active MTrPs can only be diagnosed by systematic palpation

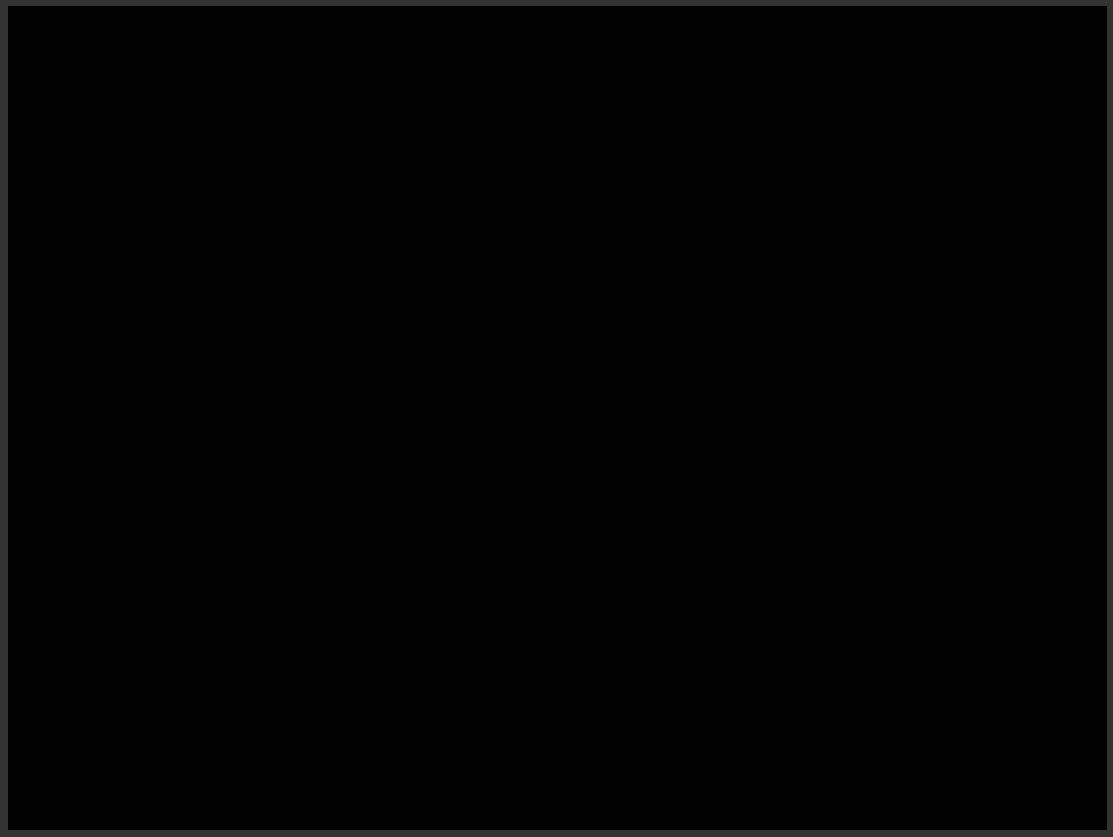
Hans-Werner Weisskircher
www.trigger-point.com

Apply *Firm* Pressure



Hans-Werner Weisskircher www.trigger-point.com

Identify the “Right” or Active MTrP



Reassure Patient by First Touching Non-painful Area

Reassure Patient by First Touching Non-painful Area

Orofacial Pain Clinic of Pantanal, Brazil

Reynaldo Leite, DDS, MS

Flavio Mello, MD, MS

Travell and Simons' Trigger Point Manual

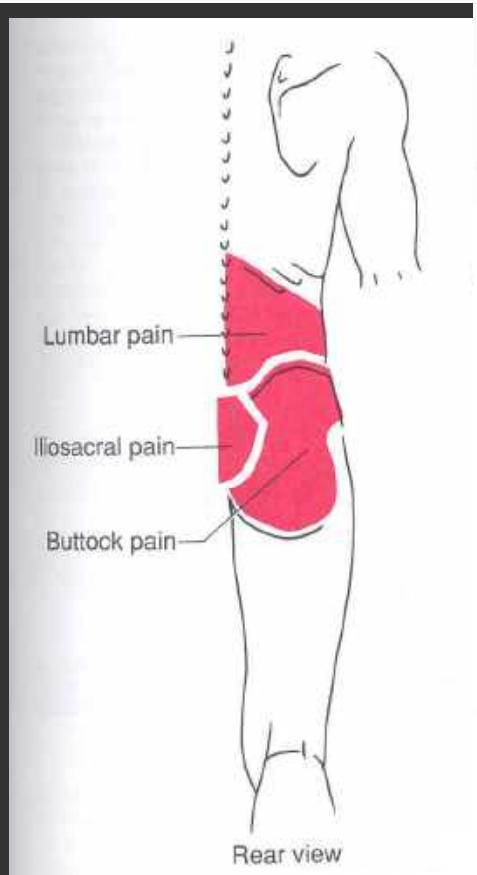


Figure 3.1. Designated areas *(red)* within the low torso region where patients may describe myofasc pain. The pain may be referred to each designated

PAIN GUIDE

ABDOMINAL PAIN

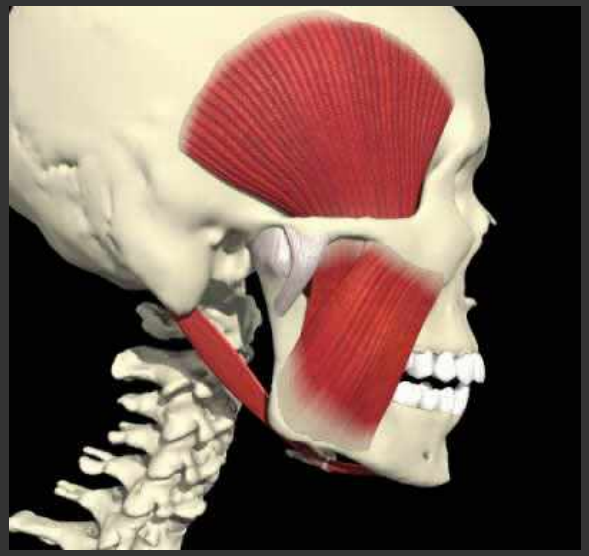
Rectus abdominis (49.2*B*, p. 664)[9]
Obliquus externus abdominis (49.1*C*, p. 662)[9]
Iliocostalis thoracis (48.1*B*, p. 638)[9]
Multifidi (48.2*B*, p. 639)[9]
Quadratus lumborum (4.1*A*, p. 30)
Pyramidalis (49.2*D*, p. 664)[9]

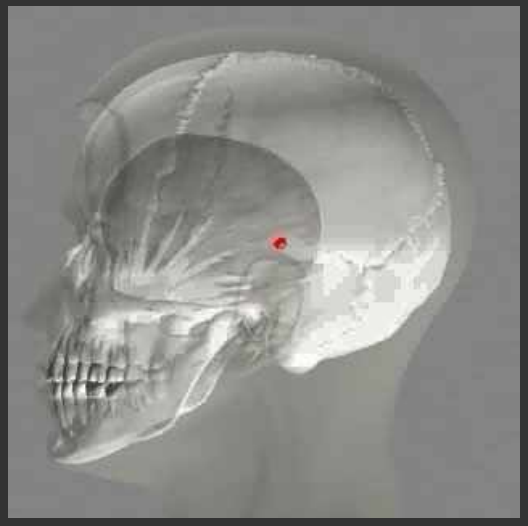
BUTTOCK PAIN

Gluteus medius (8.1 TrP_1 and TrP_2, p. 151)
Quadratus lumborum (4.1*A* and 4.1*B*, p. 30)
Gluteus maximus (7.1*A*, *B*, and *C*, p. 133)
Iliocostalis lumborum (48.1*C*, p. 638)[9]
Longissimus thoracis (48.1*D*, p. 638)[9]
Semitendinosus and semimembranosus (16.1*A*, p. 317)
Piriformis (10.1, p. 188)
Gluteus minimus (9.1, p. 169 and 9.2, p. 169)
Rectus abdominis (49.2*A*, p. 664)[9]
Soleus (22.1 TrP_3, p. 429)

The Trigger Point Manual.
Simons, Travell and Simons, 1999

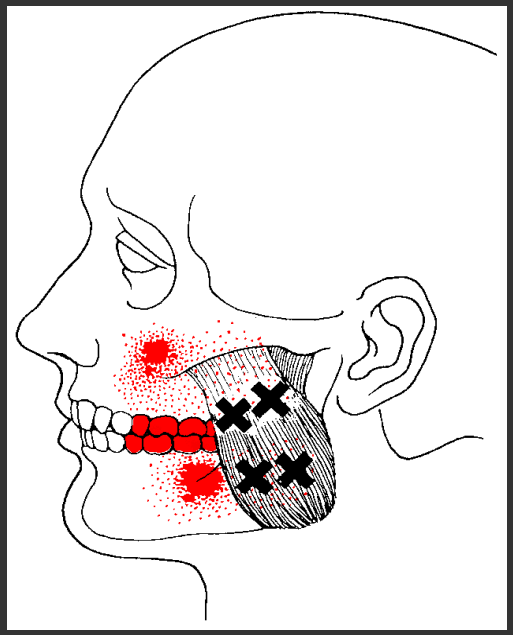
It's Important to Learn Functional Anatomy, How to Palpate the Muscle and Referral Patterns of Pain

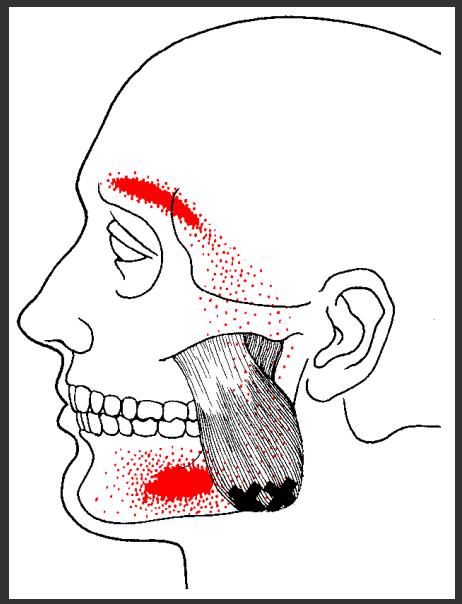


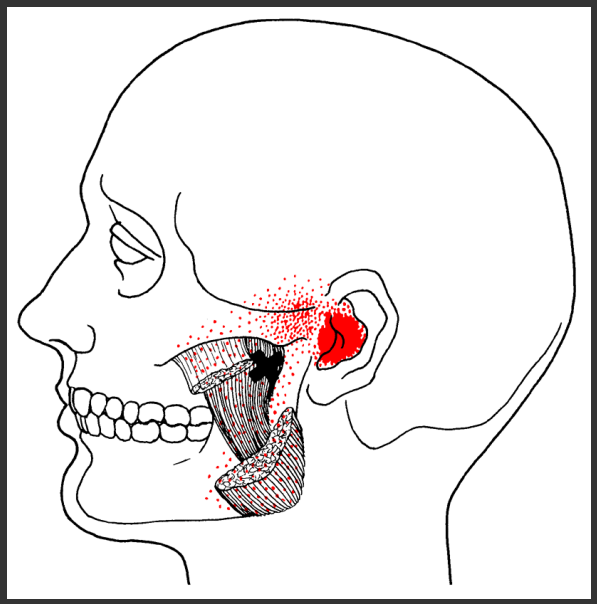


Hans-Werner Weisskircher www.trigger-point.com

Masseter Trigger Points

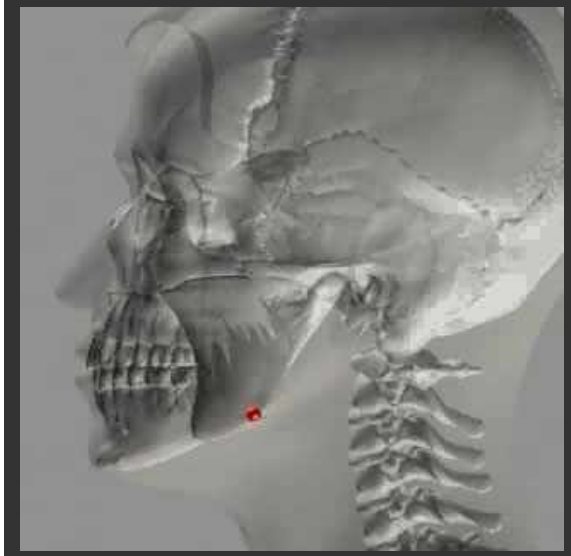


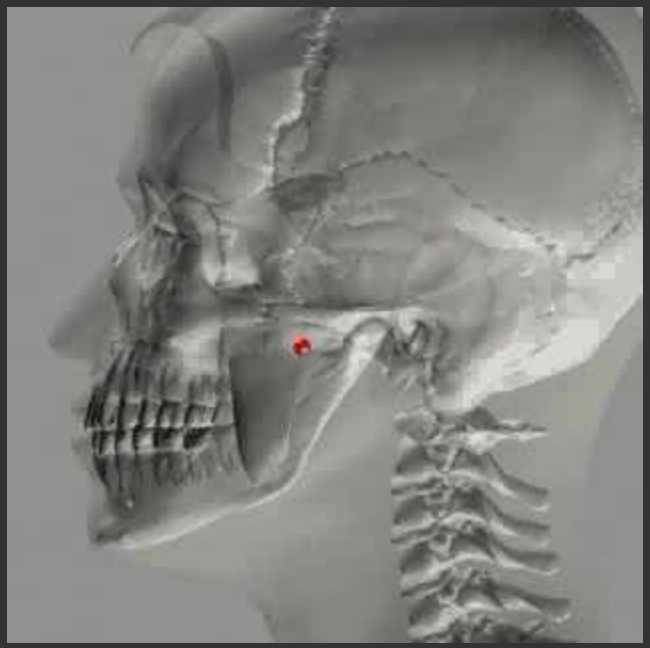


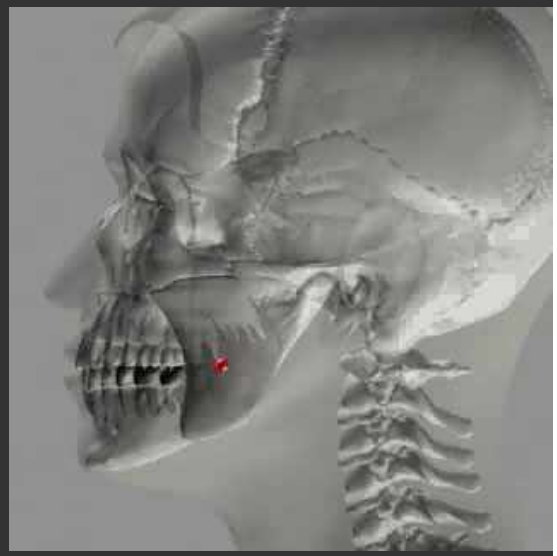


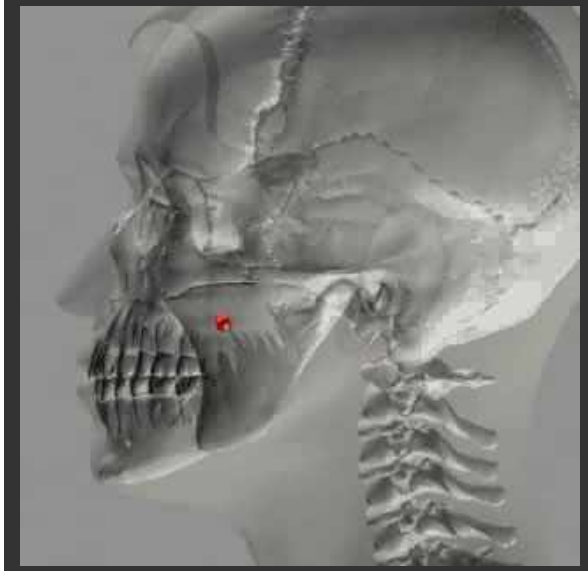
Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.

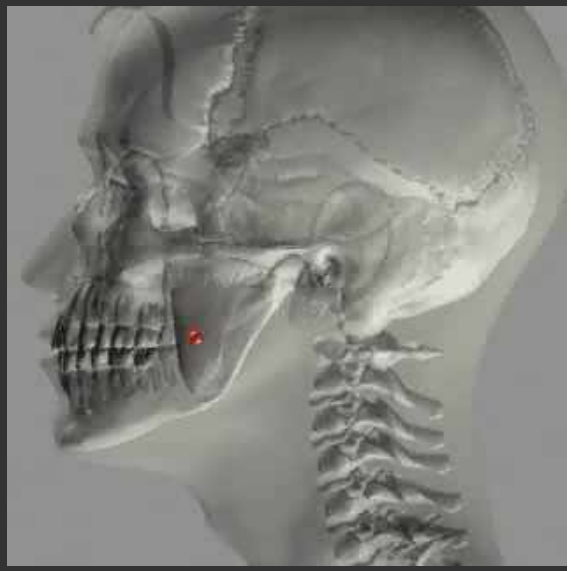
Masseter Trigger Points







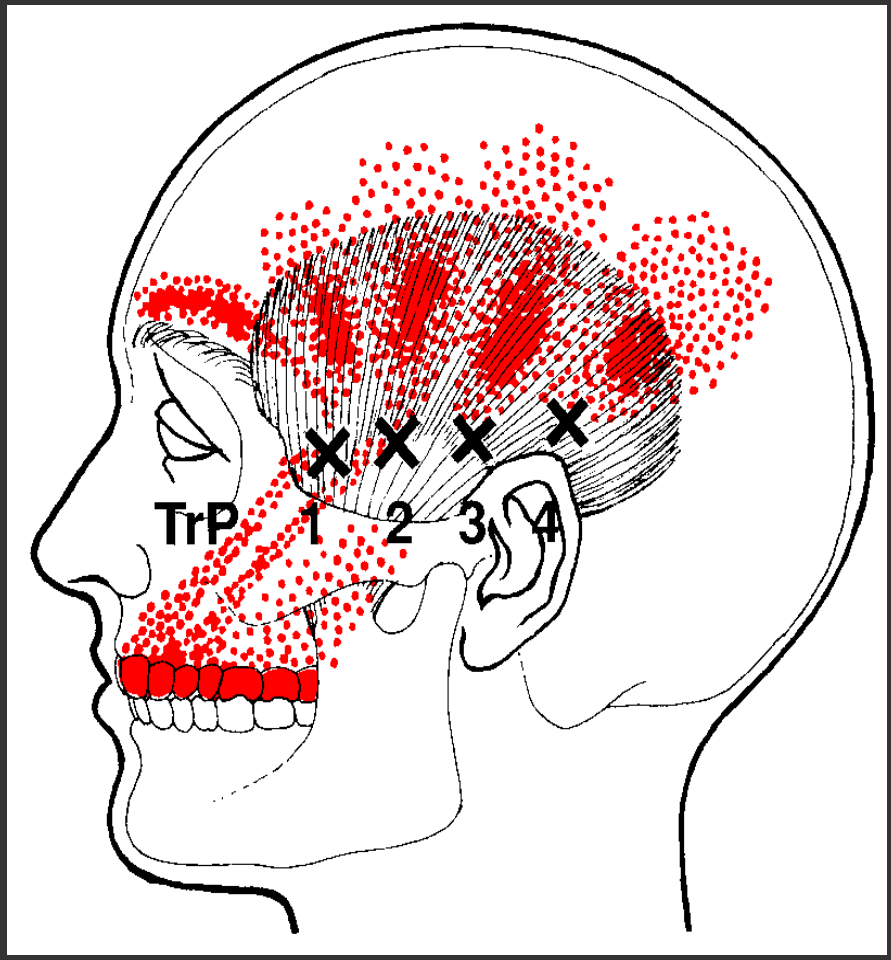




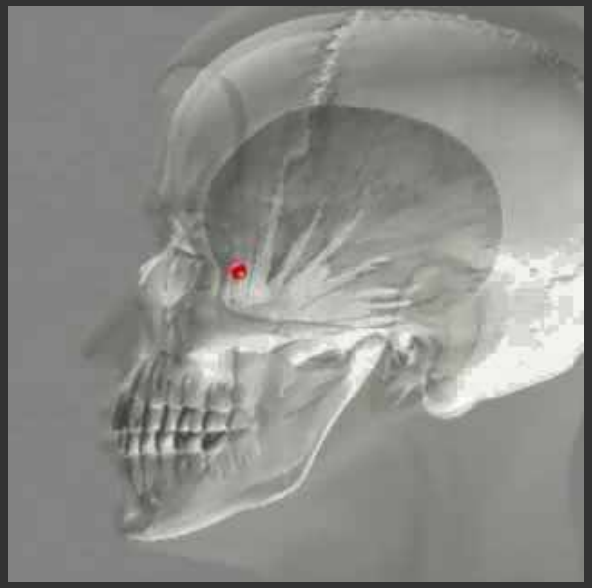
Hans-Werner Weisskircher
www.trigger-point.com

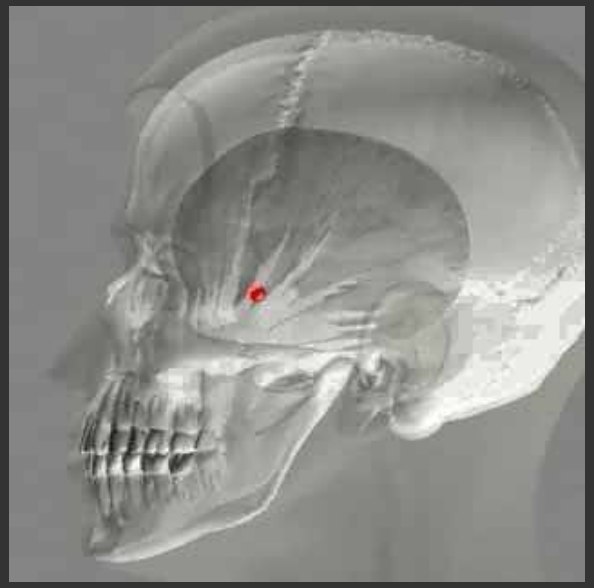
Hans-Werner Weisskircher
www.trigger-point.com

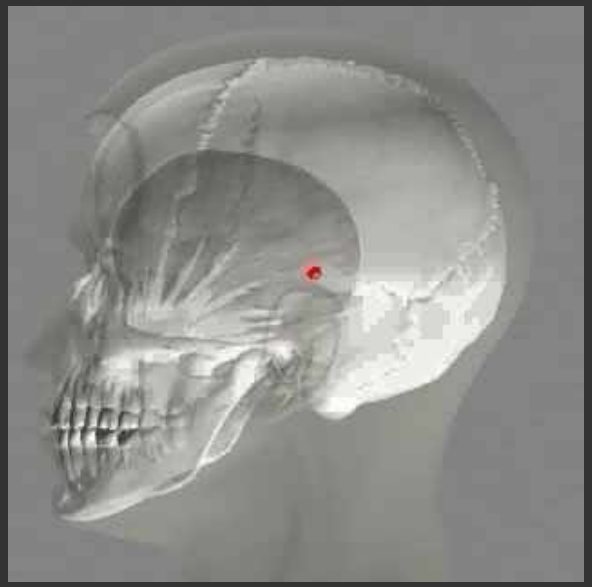
Temporalis

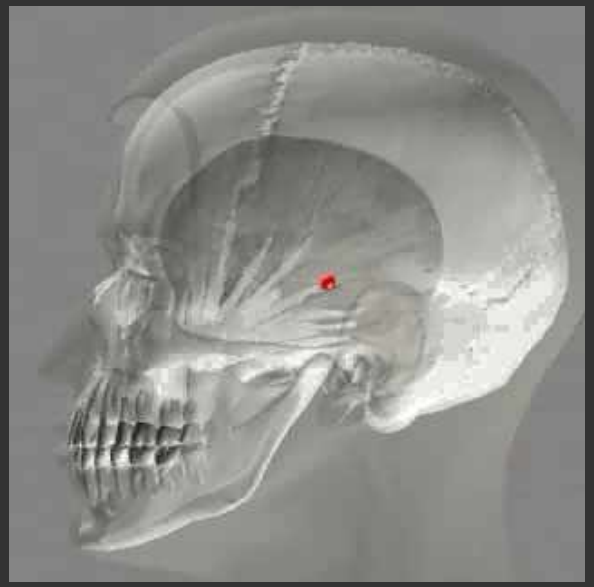


Temporalis Trigger Points







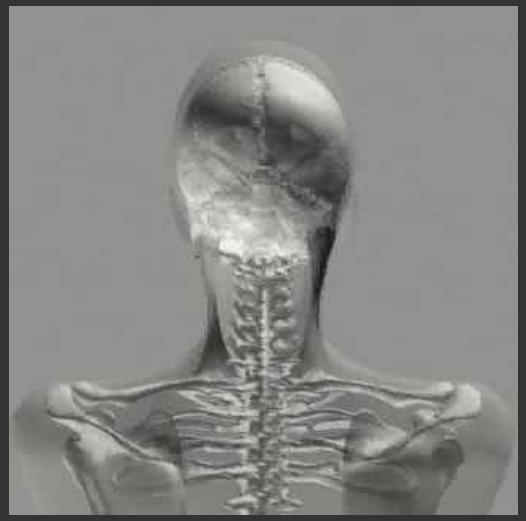


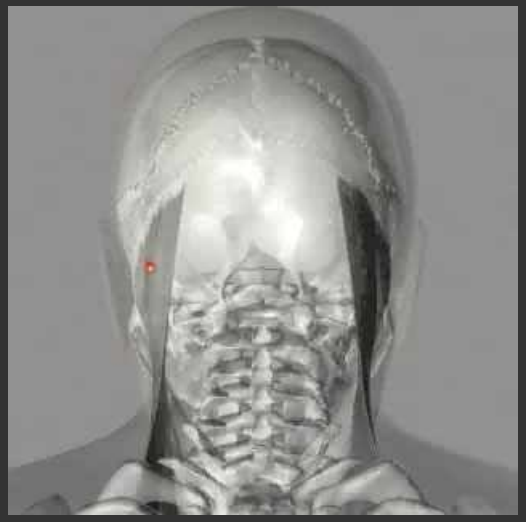
Hans-Werner Weisskircher
www.trigger-point.com

Temporalis Trigger Points

Hans-Werner
Weisskircher
www.trigger-
point.com

Referral Patterns of Sternocleiodomastoid MTrPs

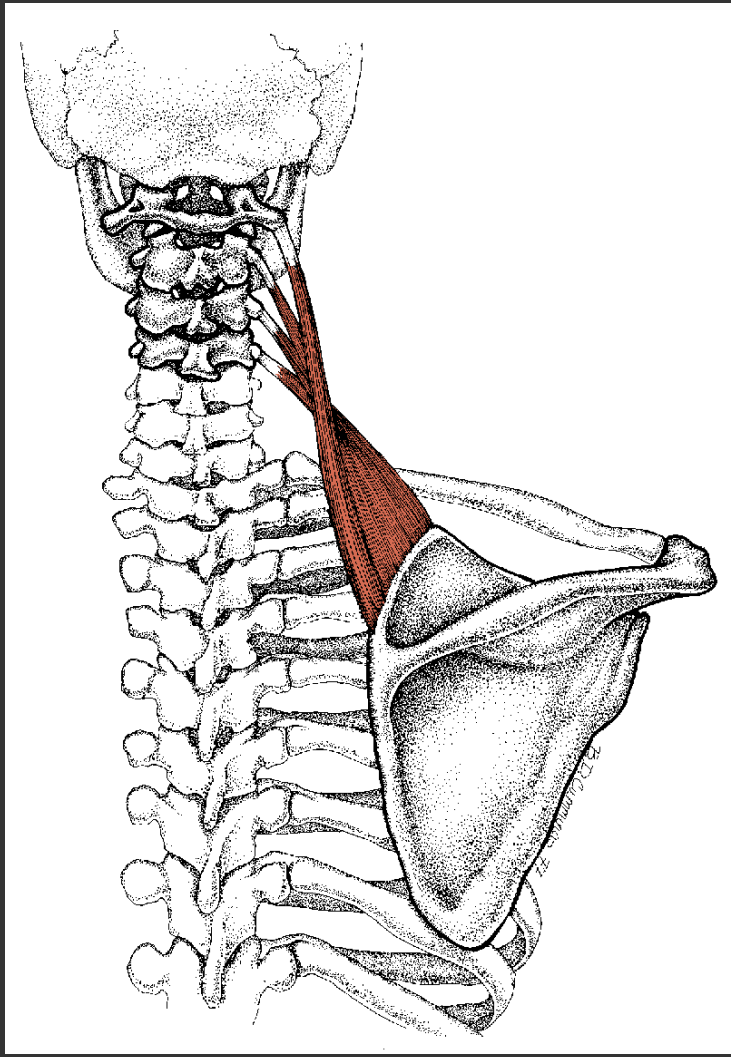




Hans-Werner Weisskircher
www.trigger-point.com

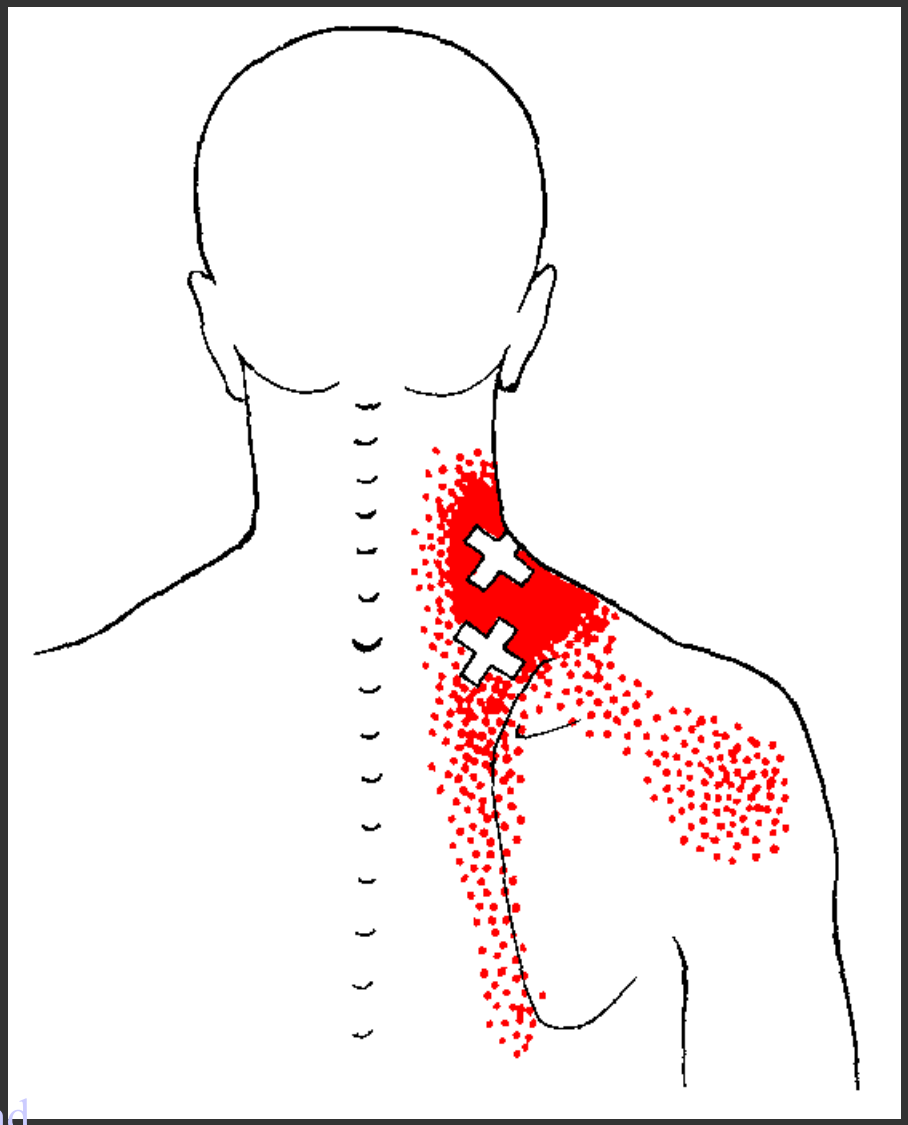
Levator scapulae

- **Superior: Transverse Processes of C1 – C4**
- **Inferior: Superior – medial border of scapula**
- **Innervation: Cervical nerves 3 and 4**



Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.

Levator scapulae



Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.

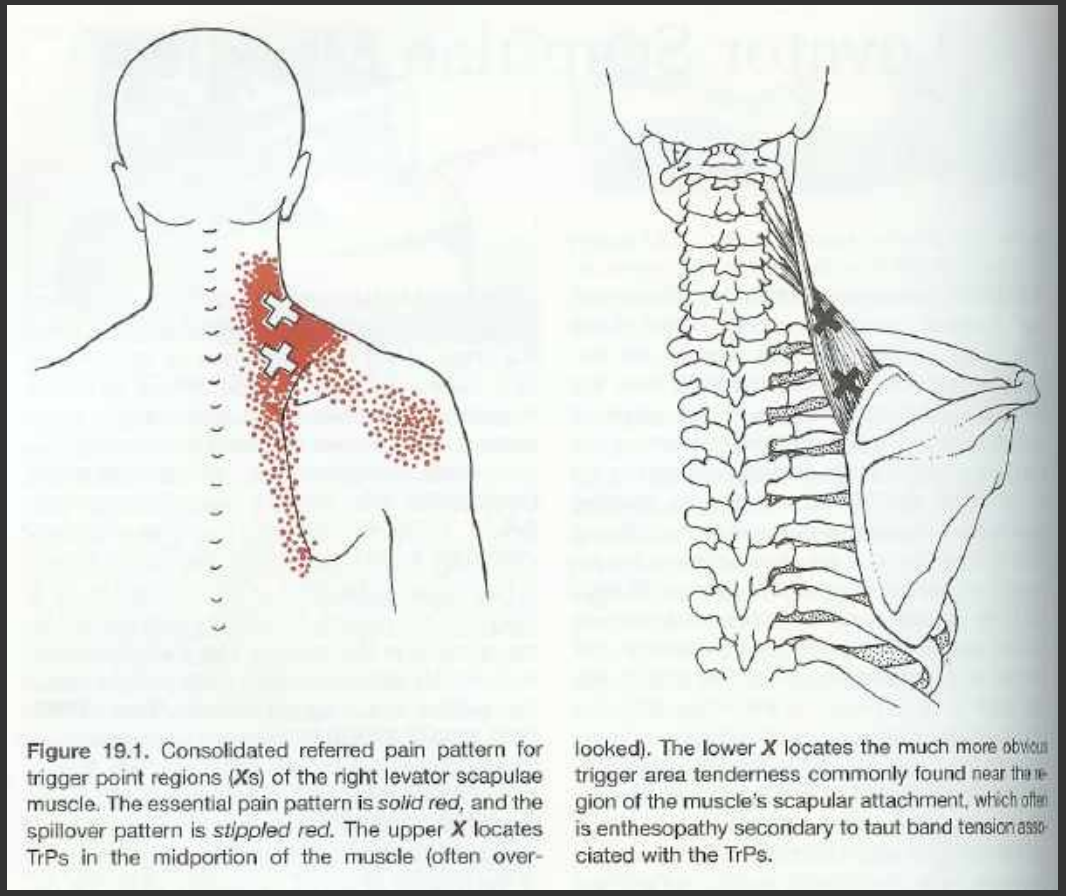


Figure 19.1. Consolidated referred pain pattern for trigger point regions (*X*s) of the right levator scapulae muscle. The essential pain pattern is *solid red*, and the spillover pattern is *stippled red*. The upper *X* locates TrPs in the midportion of the muscle (often overlooked). The lower *X* locates the much more obvious trigger area tenderness commonly found near the region of the muscle's scapular attachment, which often is enthesopathy secondary to taut band tension associated with the TrPs.

Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.

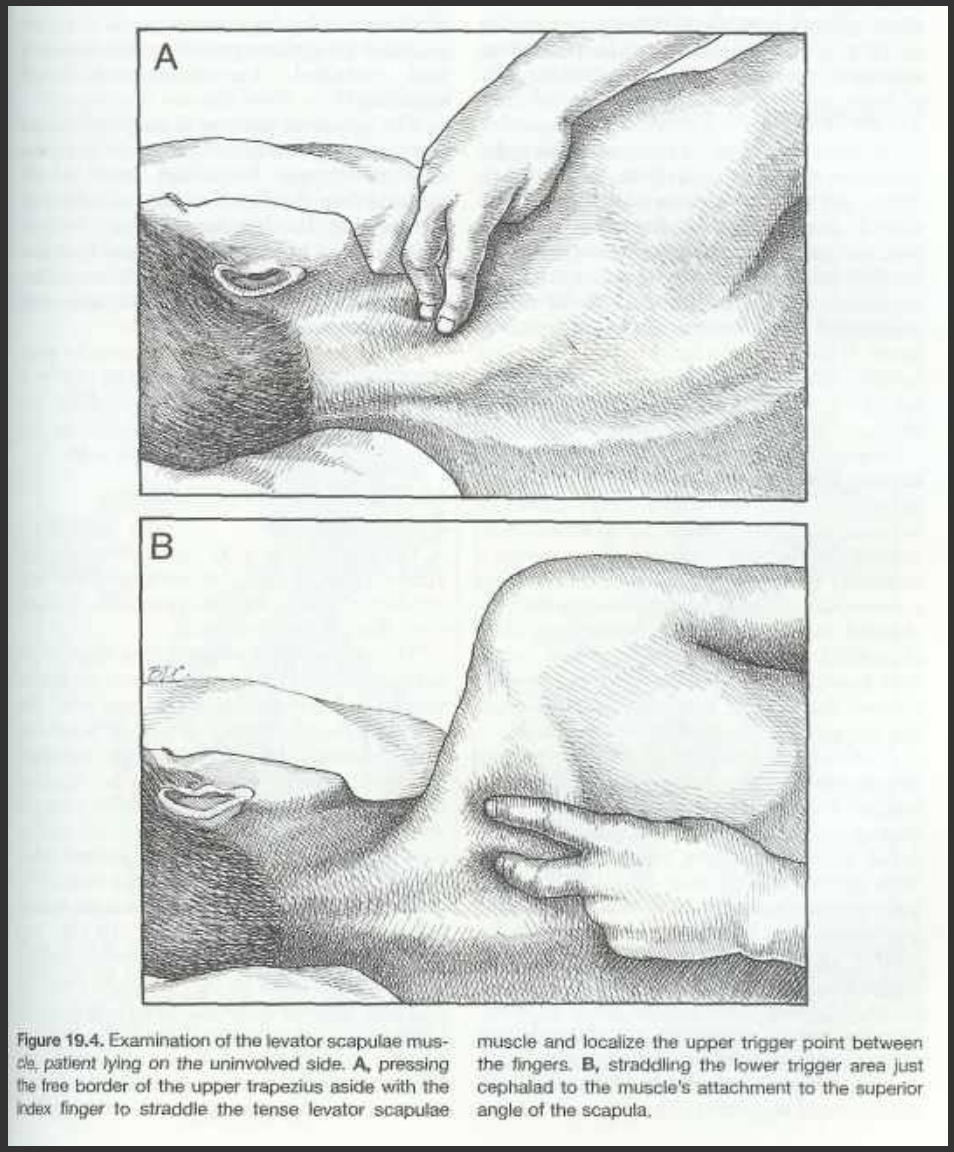


Figure 19.4. Examination of the levator scapulae muscle, patient lying on the uninvolved side. **A,** pressing the free border of the upper trapezius aside with the index finger to straddle the tense levator scapulae muscle and localize the upper trigger point between the fingers. **B,** straddling the lower trigger area just cephalad to the muscle's attachment to the superior angle of the scapula.

Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.

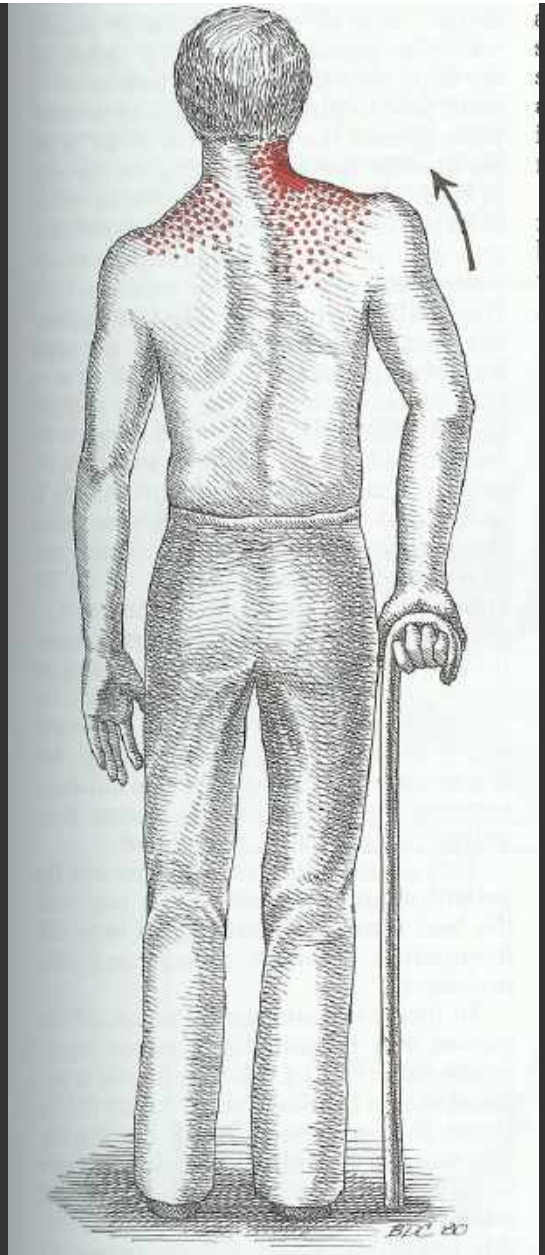
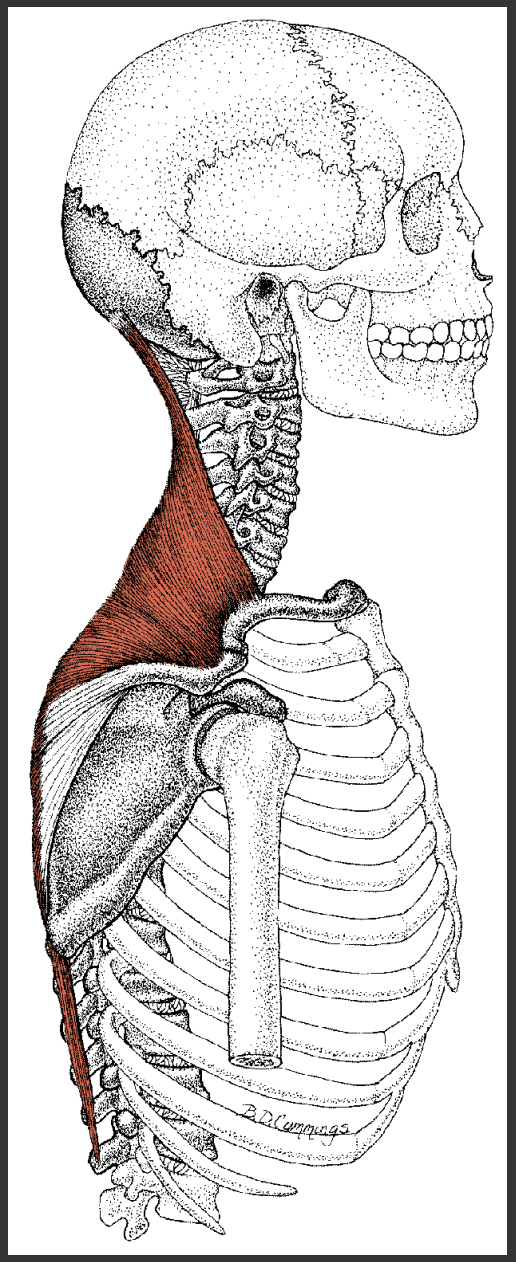


Figure 19.3. Activation primarily of right levator scapulae trigger points, and secondarily of other muscles on the left, by walking with a cane that is too long, held in the right hand. The patient's resultant pain distribution is shown in *red*. The *arrow* indicates the undesirable lift of the right shoulder so the long cane can

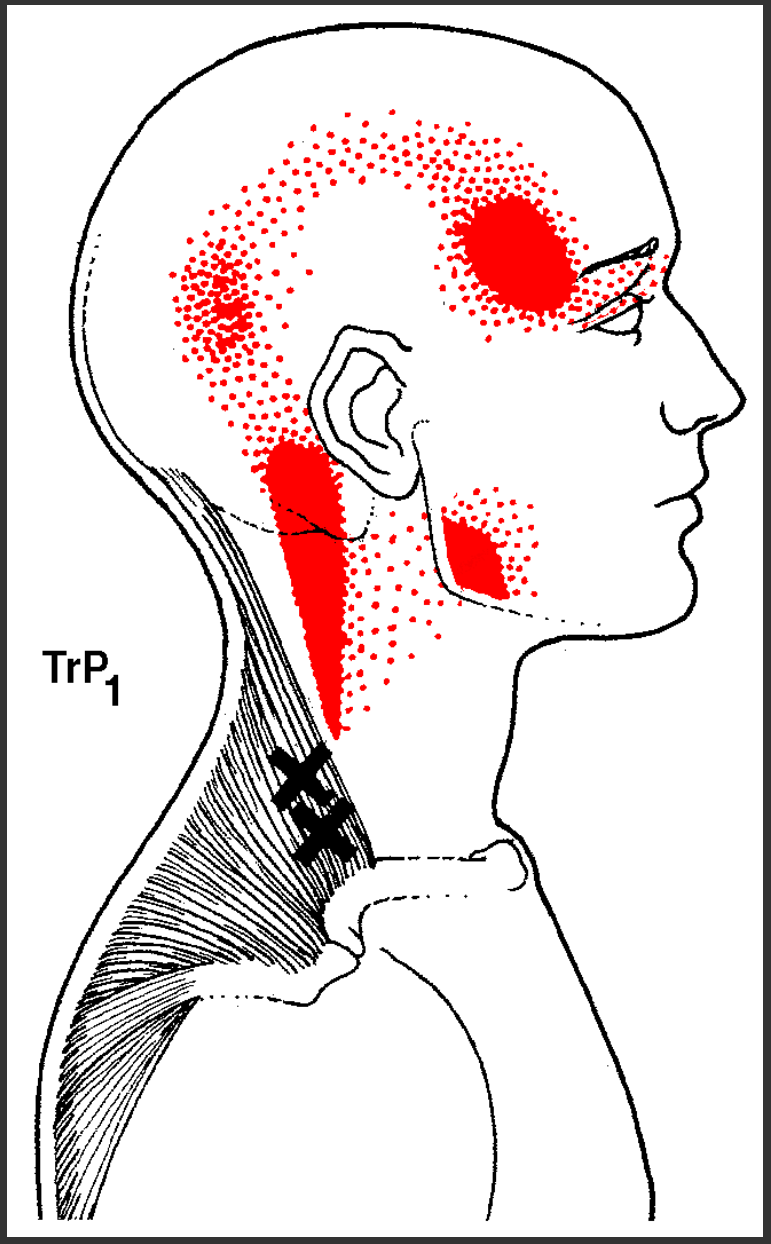
Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.

Upper Trapezius



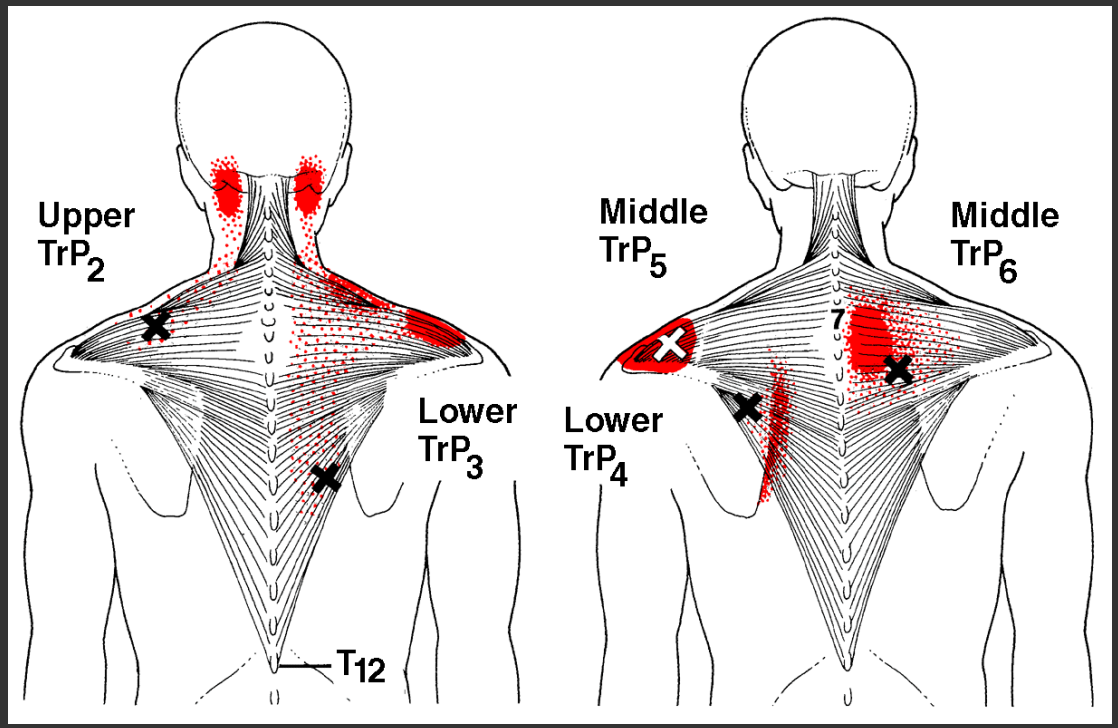
Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.

Upper Trapezius

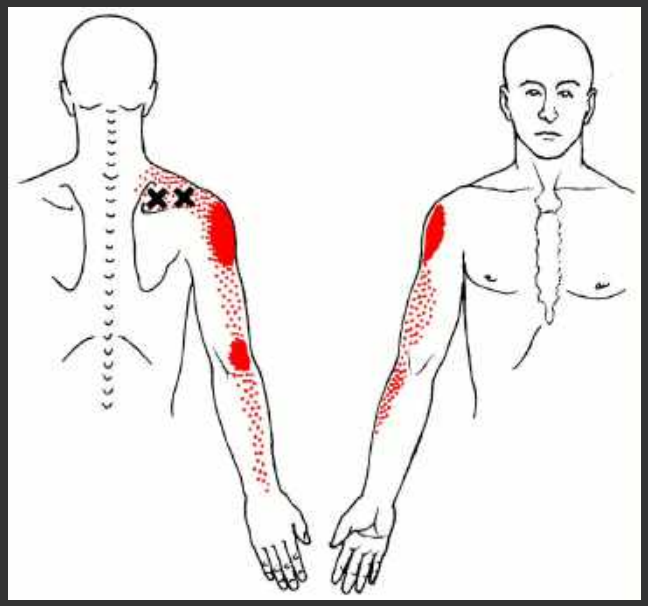


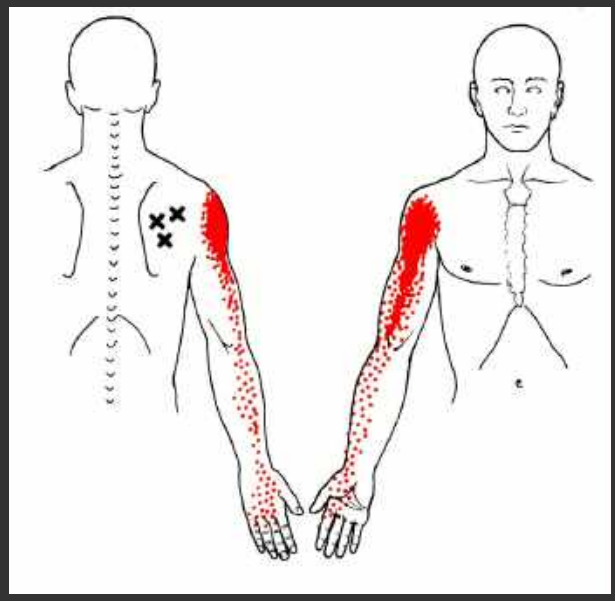
Hans-Werner Weisskircher
www.trigger-point.com

Trapezius

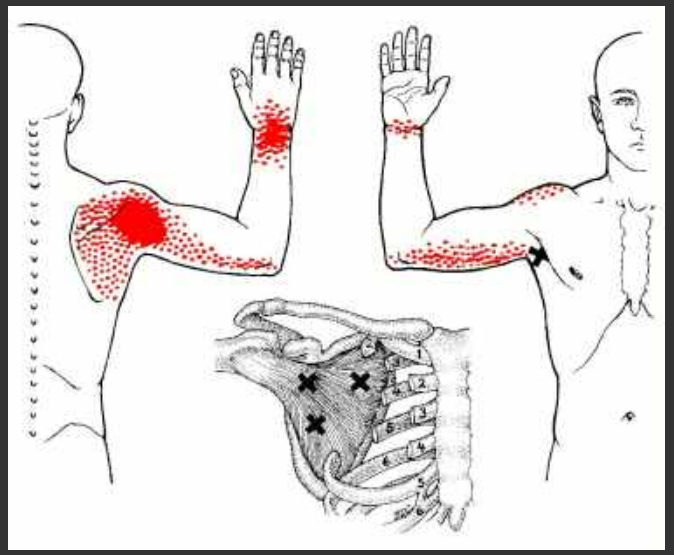


Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.





Rotator Cuff Muscles



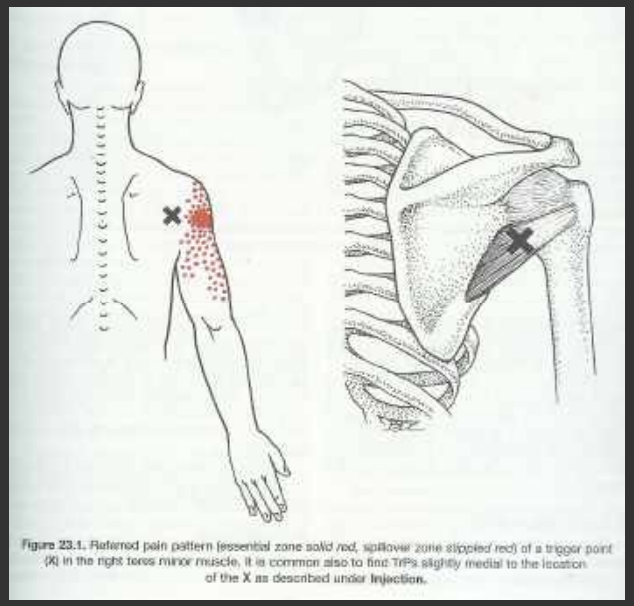
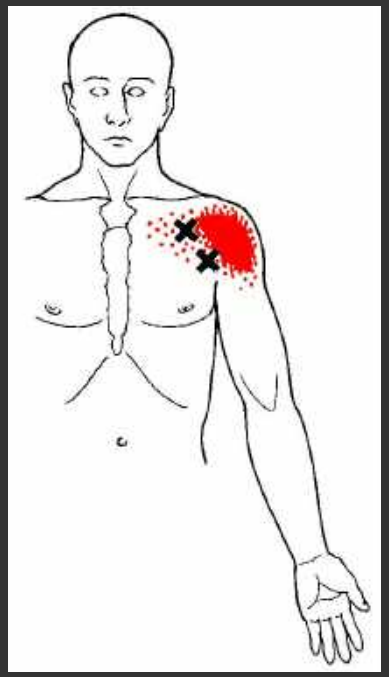
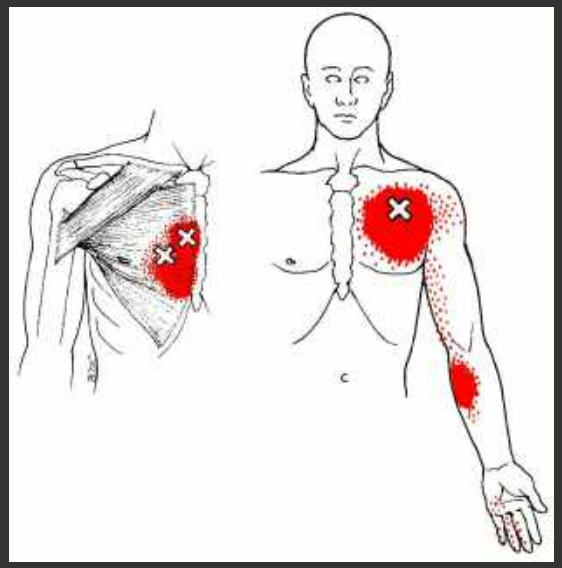


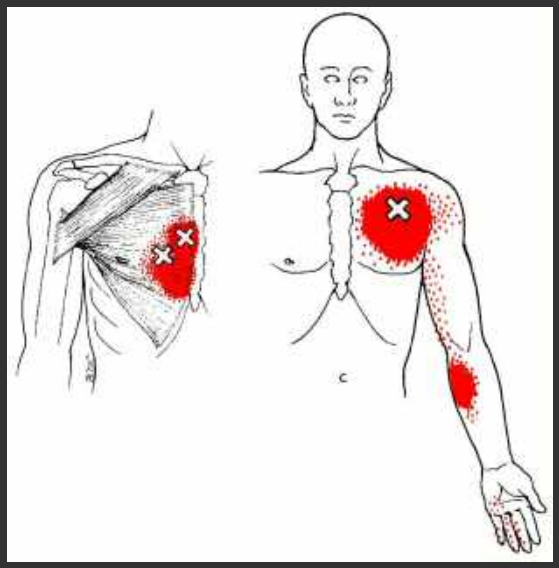
Figure 23.1. Referred pain pattern (essential zone solid red, spillover zone stippled red) of a trigger point (X) in the right teres minor muscle. It is common also to find TrPs slightly medial to the location of the X as described under **Injection.**

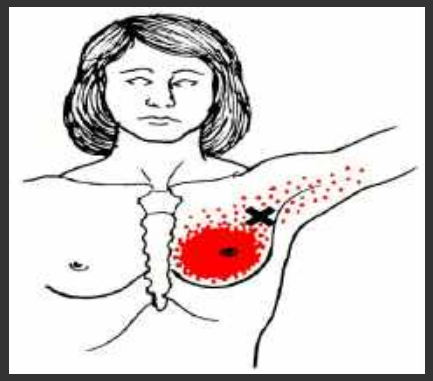
Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.

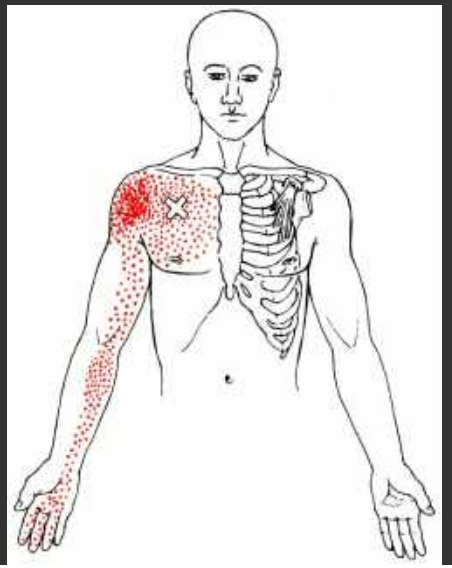
Pectoralis Major and Minor





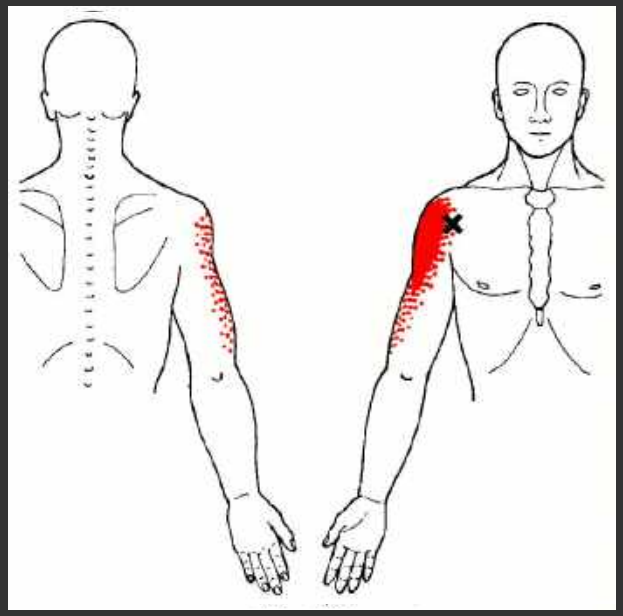


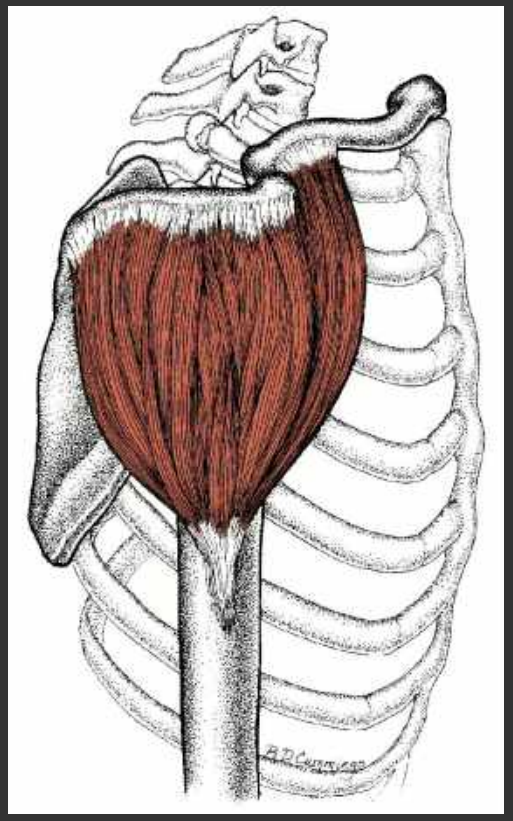


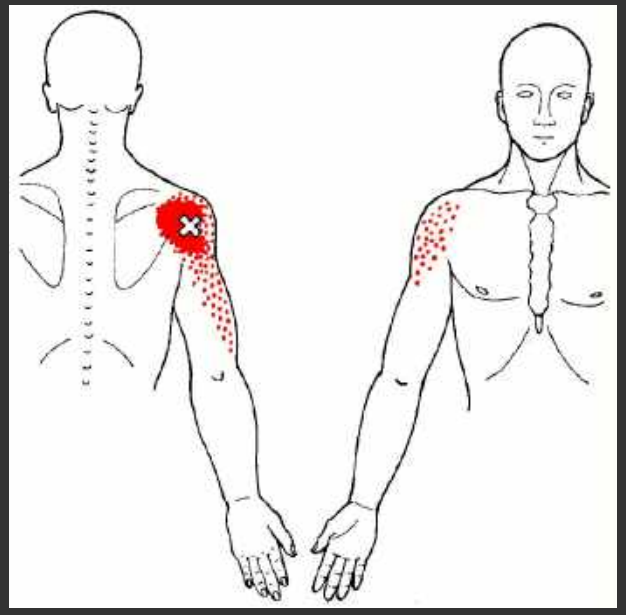


Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.

Deltoid

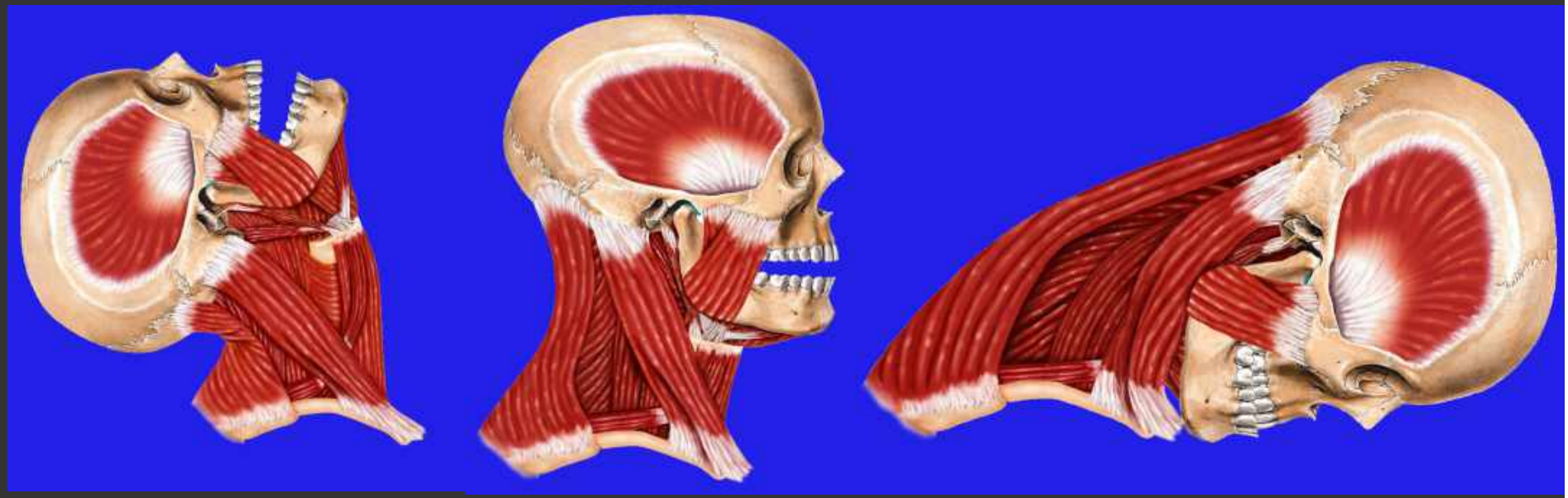


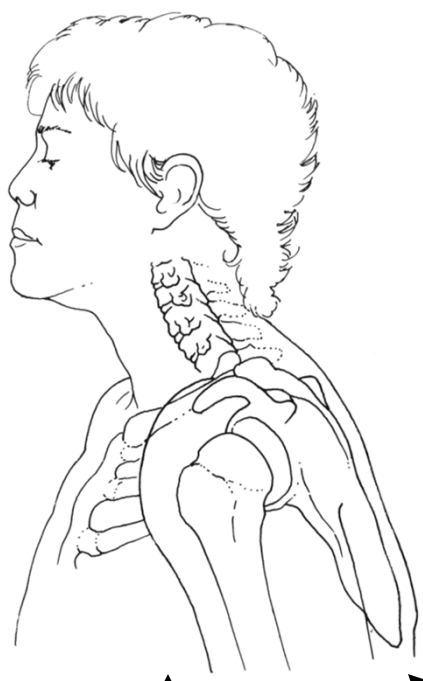


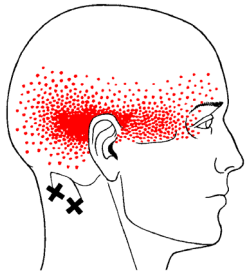


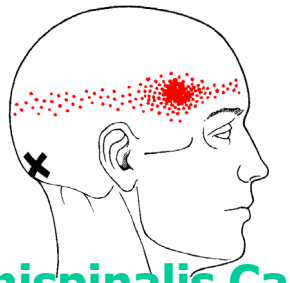
Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.

Whiplash Injuries

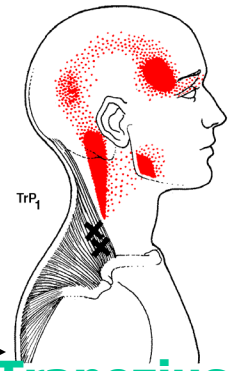




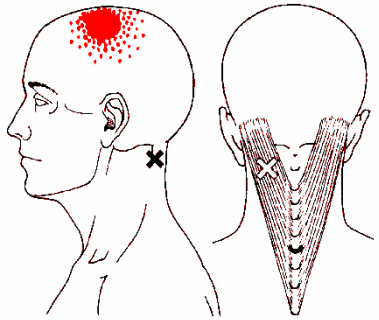




Semispinalis Capitis

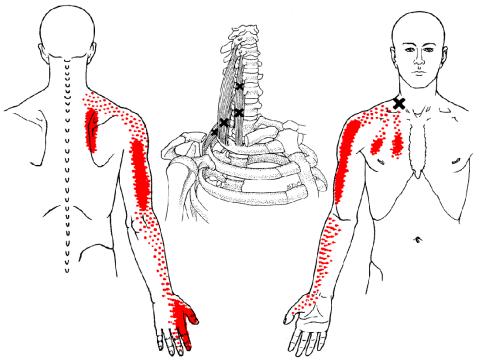


Trapezius

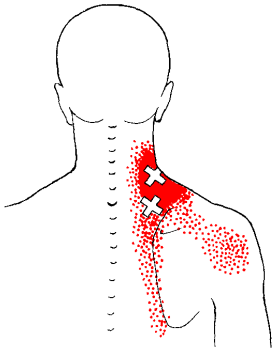


Splenius Capitis

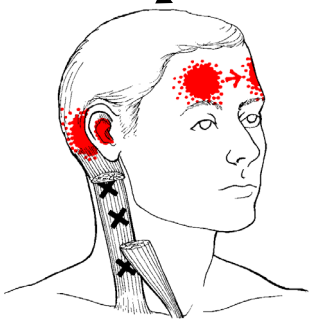
Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.

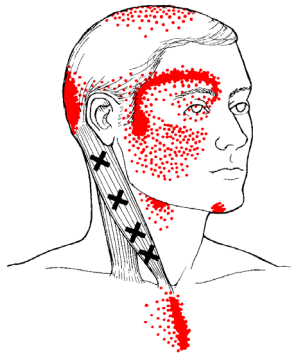


Scalenes



Levator Scapulae

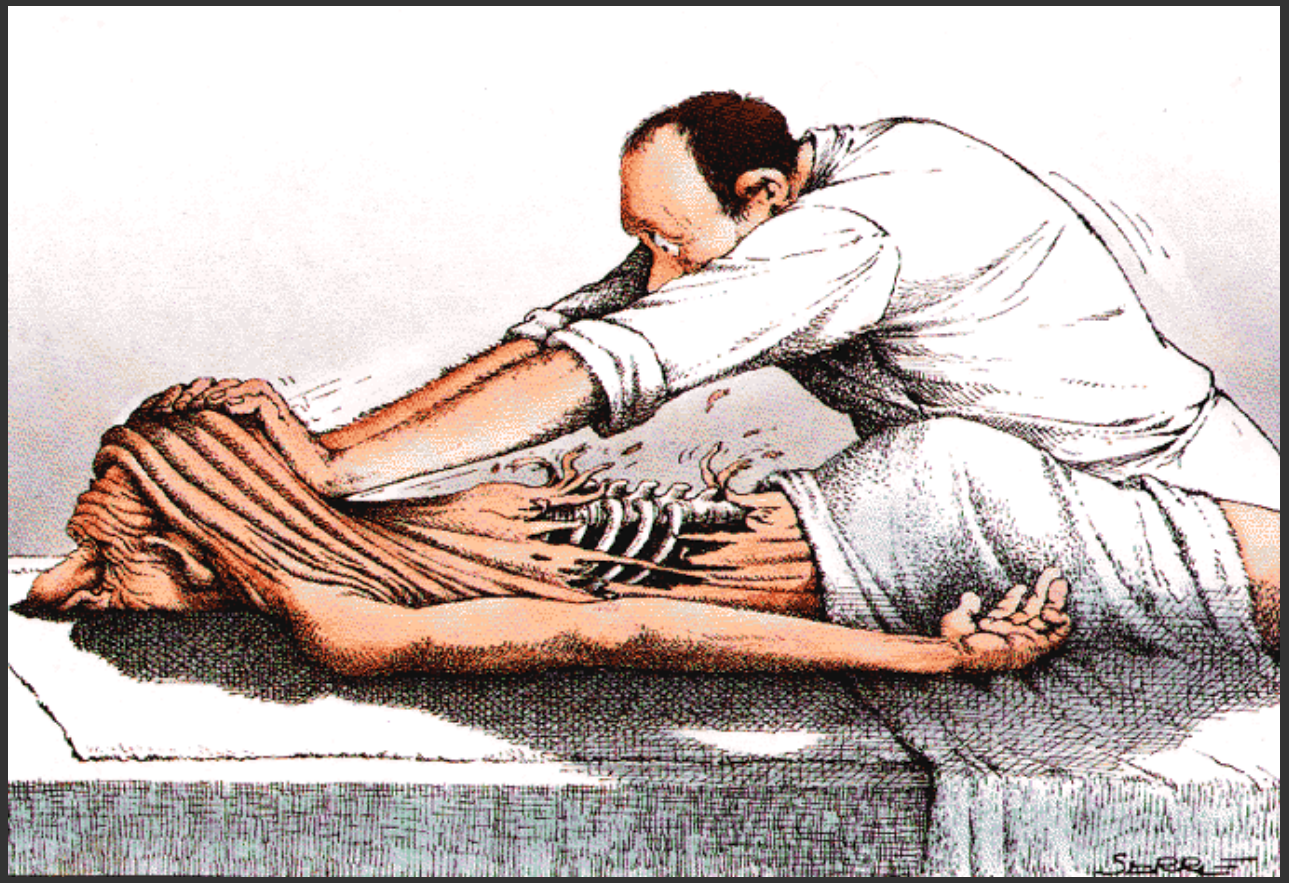




Sternocleidomastoid Muscles

Whiplash Injuries

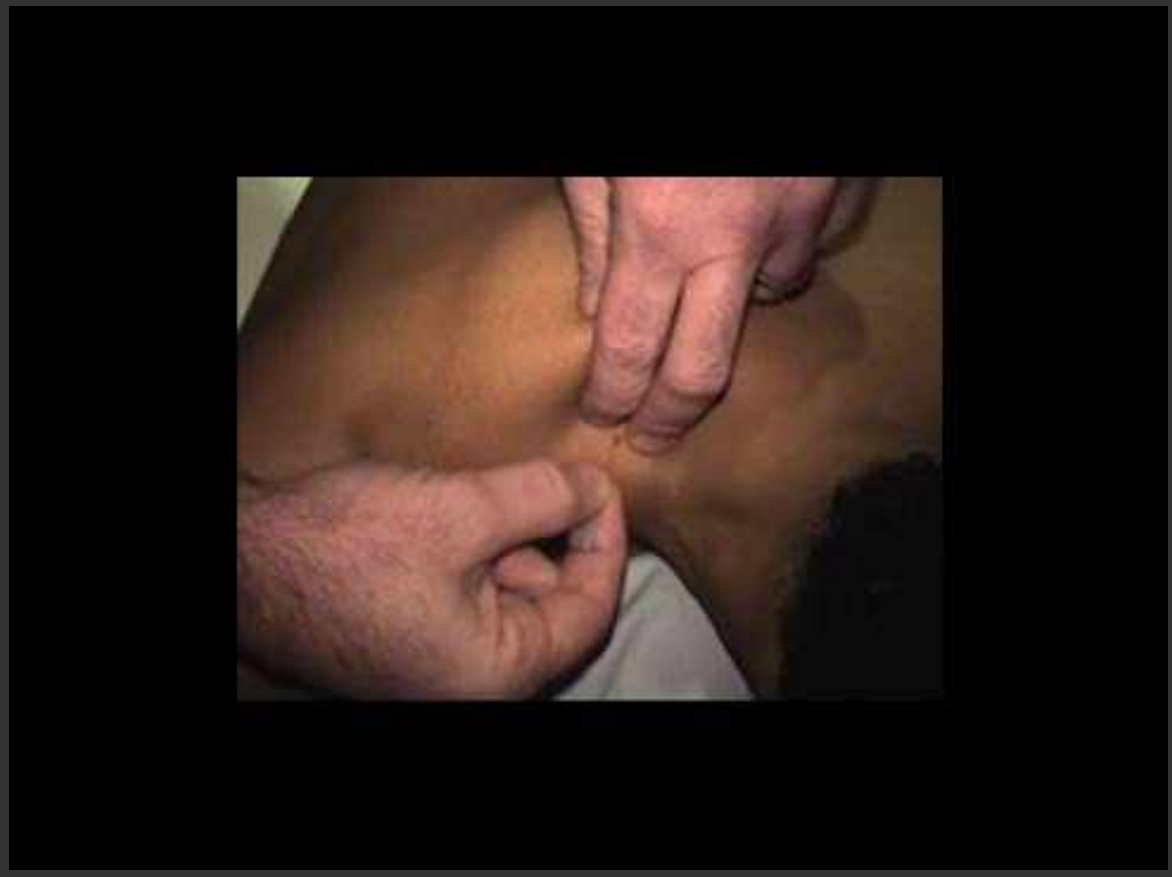
Manual Therapy



Manual Therapy

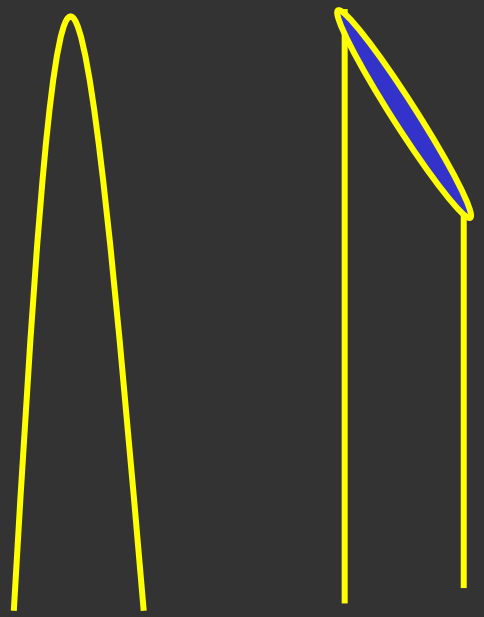
Trigger Point Injections and Dry Needling: Proper Technique to Elicit Local Twitch Responses is Essential

Hong CZ *Arch Phys Med Rehab* **1994;73:256**



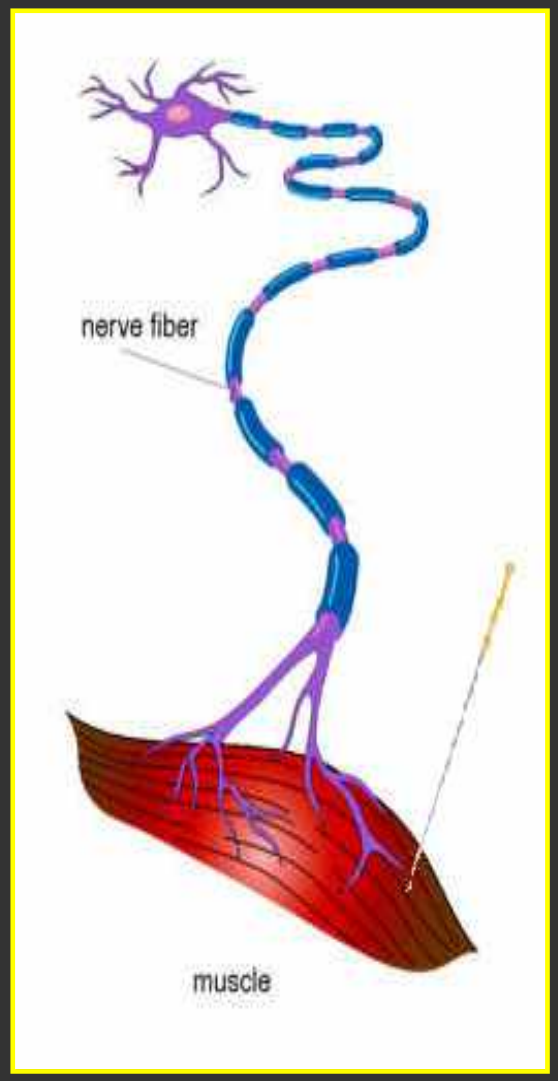
Comparison of Needle Tips

Rounded acupuncture needle tip pushes cells aside rather than piercing them



Sharp beveled hypodermic needle tip acts like a miniature scalpel capable of piercing, cutting and tearing cells

Possible Dry Needling Mechanisms



- Activate pain inhibitory system
  - Via Aδ and Aβ nerve fibers
- Stretch connective tissue
  - Fibroblast stretch via mechanical stimulation
- Increase blood flow
  - By releasing vasodilatory biochemicals
- Relax muscle fibers
  - Reduce overlap between actin and myosin filaments; interrupt motor end-plates
  - Decreases SEA

Caigne et al., 2013

Overview of Potential Dry Needling Physiological Effects

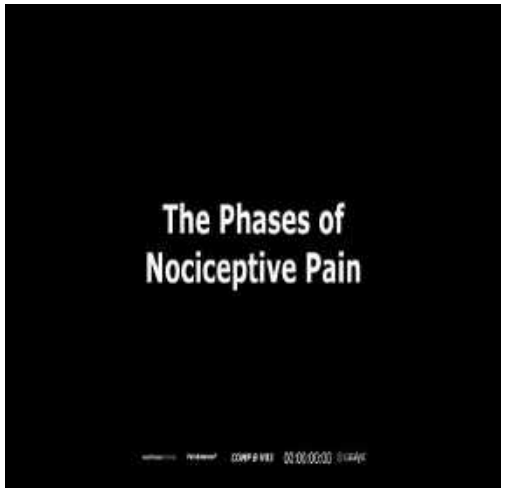
INCREASE IN BLOOD FLOW

Release of SP and CGRP

Local Microtrauma

Needle Insertion

Mechanical Stimulation



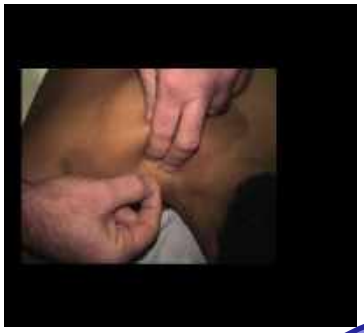
Inhibition of C-fibers

Activation of Aδ fibers

Activation of Aβ fibers

LTR

SEA , ACh, AChR, & Endplate Sensitivity and AChEsterase @ Endplate



Placebo Effect?!

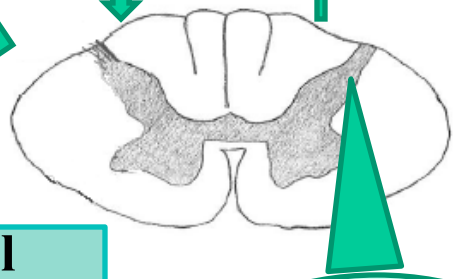
PAIN MATRIX

SUPRASPINAL SITES

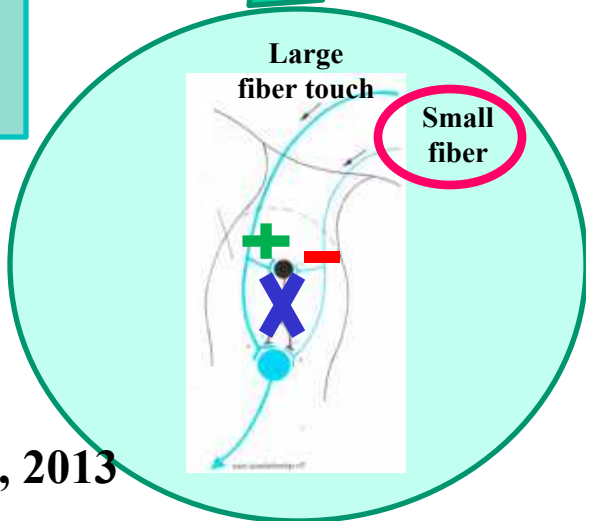
PAG

RVM

Ascending Pain Pathways



Segmental Inhibition (gate control)



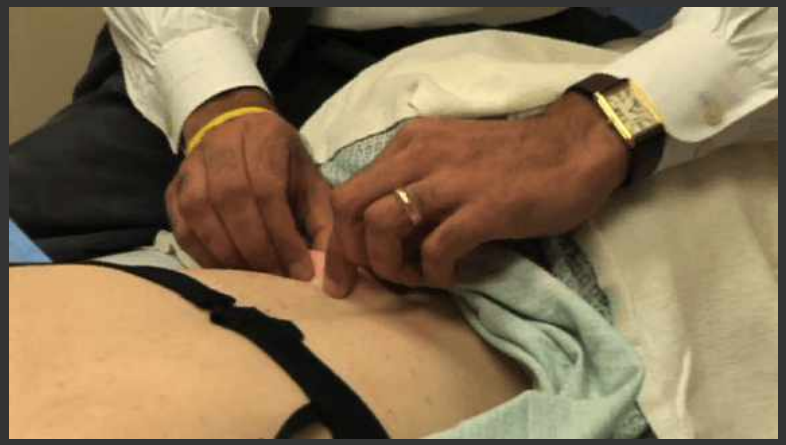
Adapted from Caigne et al., 2013

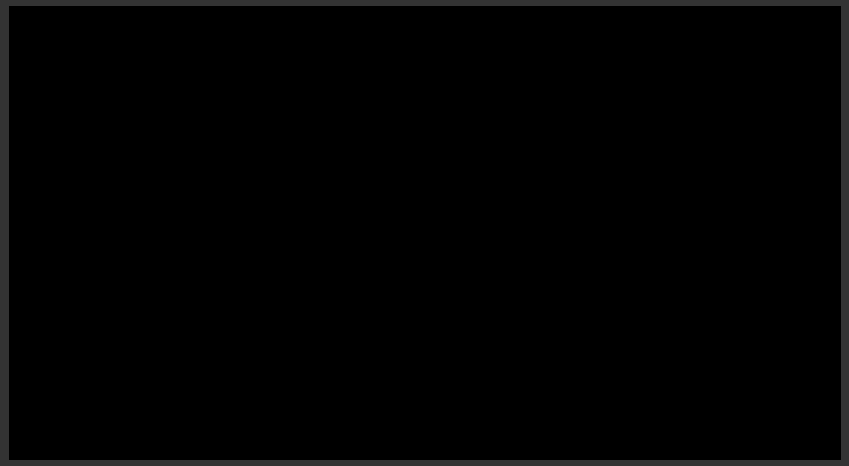
Chronic Myofascial Pain and the Sensitized Segment

There are *objective*, *reproducible* physical manifestations of sensitization in chronic neuro-musculoskeletal pain

Q*uantitative* and *objective* techniques may be used to determine the affected dermatomes, myotomes and sclerotomes involved in chronic pain

A logical treatment algorithm (e.g., needling techniques, physical modalities, etc.) may be used to desensitize the involved segments, eliminates chronic MTrPs and alleviate neuro-musculoskeletal pain

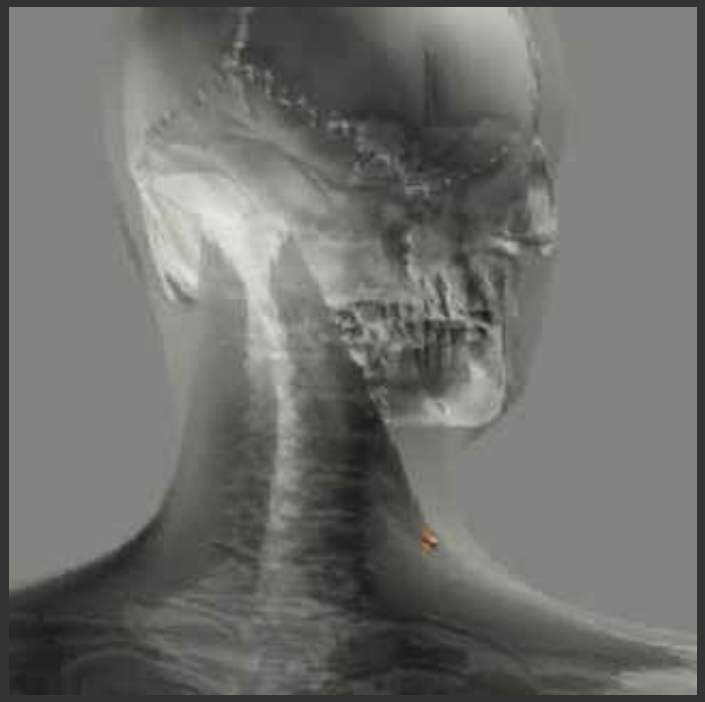




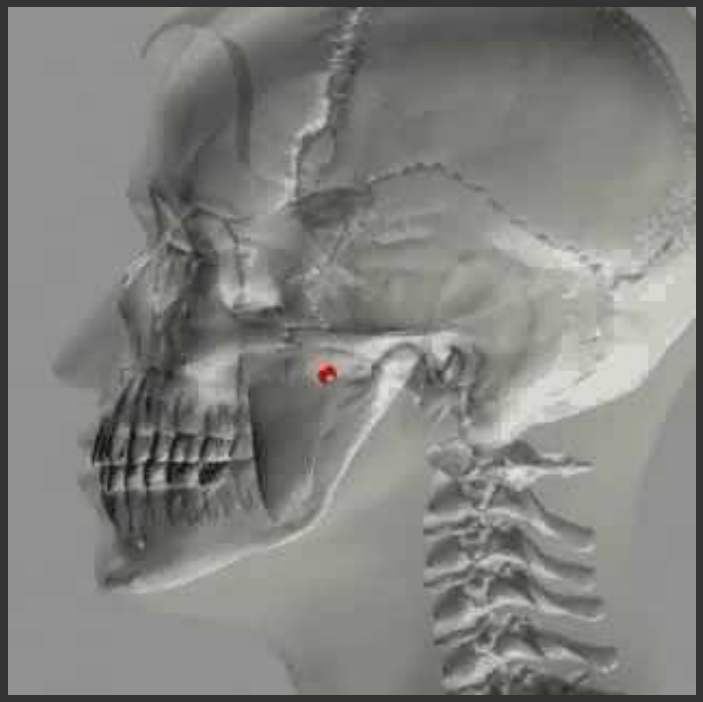
Myofascial Trigger Points and Referred Pain

It is essential to learn how to palpate the muscle, identify active MTrPs and also how to recognize common pain referral patterns

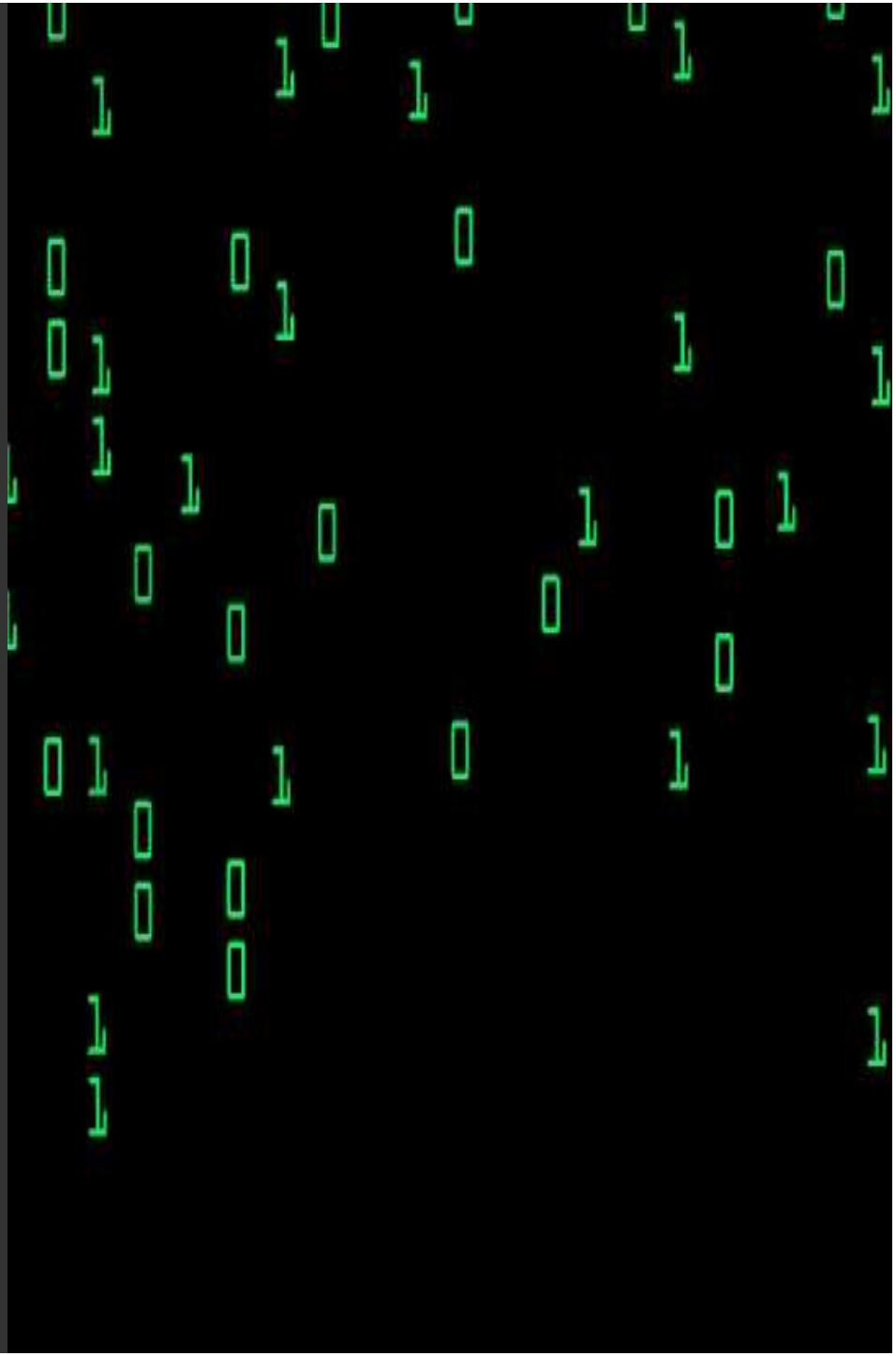
However, it is also critical to understand that active MTrPs in different muscles can have overlapping pain referral patterns making accurate diagnosis challenging, *especially* when there is central sensitization!



Hans-Werner Weisskircher
www.trigger-point.com



The Dynamic Role of Sensitization in *Neuro*-musculoskeletal Pain: *Enter the Matrix*



IT HURTS!

Pain can be **practical.** If the body is being harmed, by **tissue damage** or **infection** for instance, it can use pain to **tell the brain where and how the damage is ocurring.** But sometimes, in cases such as **traumatic injury,** pain is **best not felt. How pain works**—and **how drugs stop it:**

ENTER ›

Nociceptors are Dynamic "Two-way" Structures

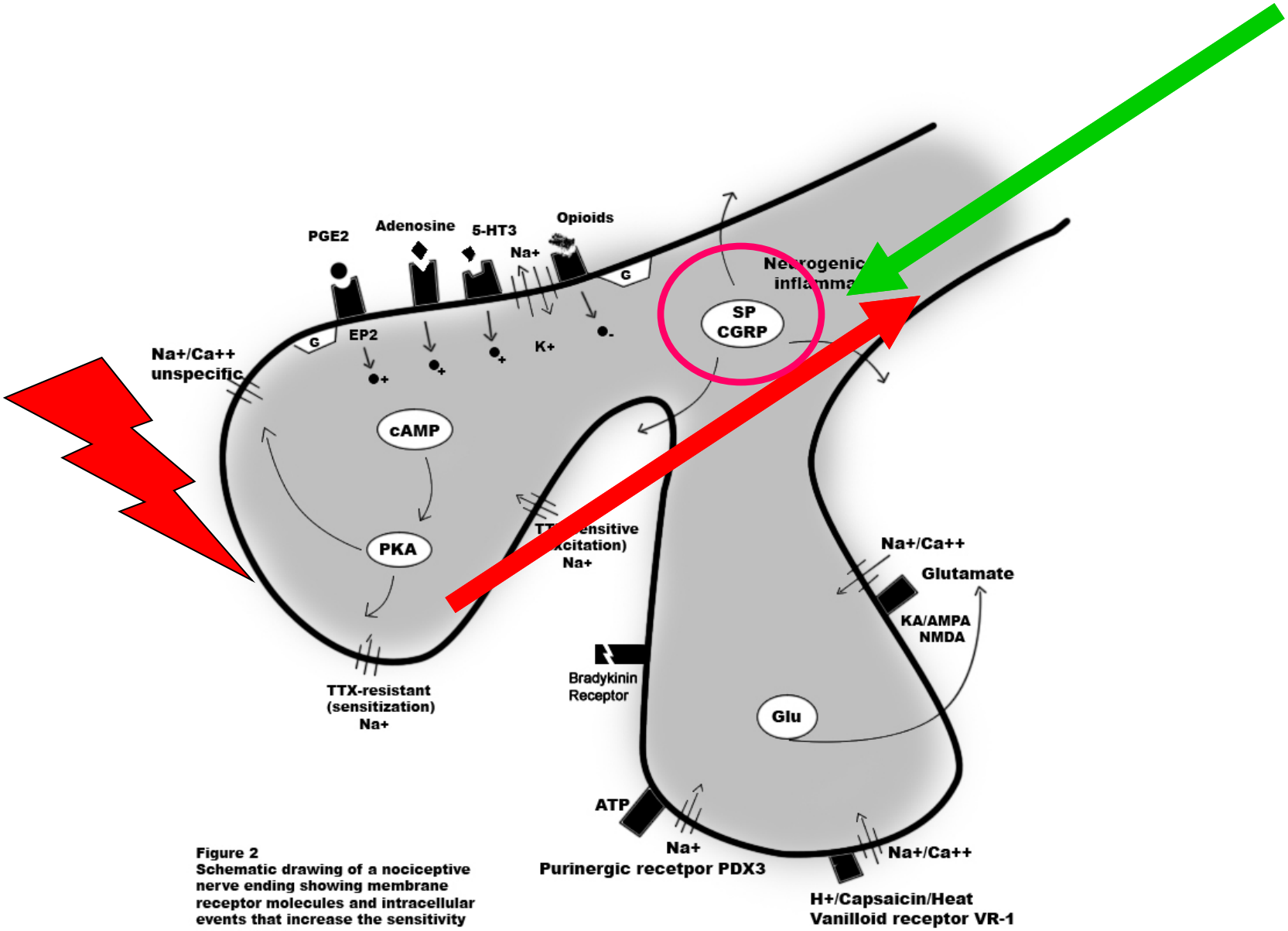
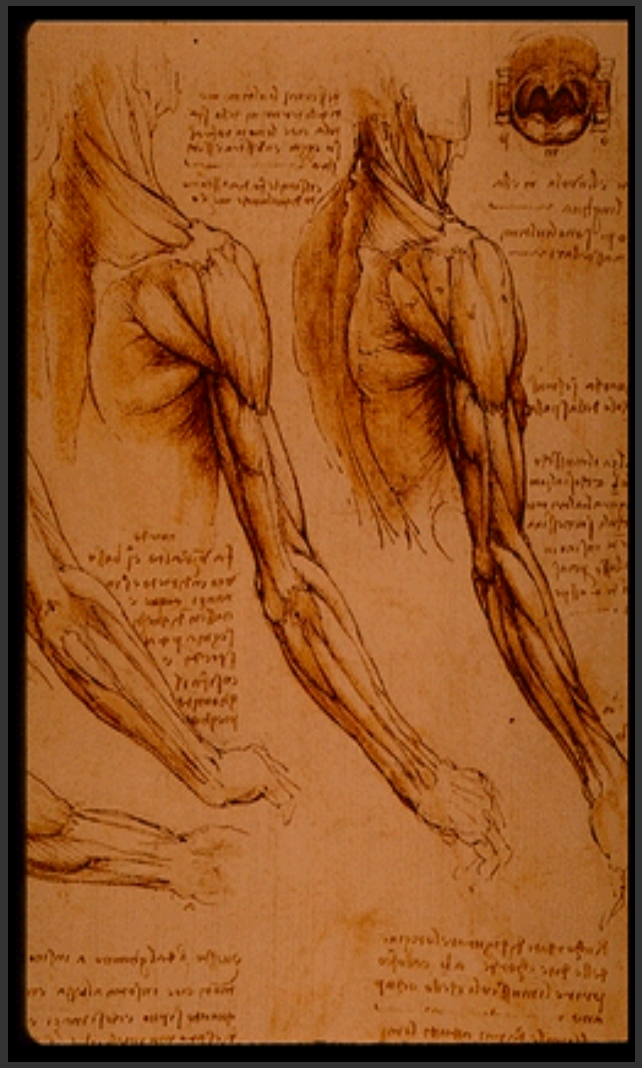


Figure 2
Schematic drawing of a nociceptive nerve ending showing membrane receptor molecules and intracellular events that increase the sensitivity of the ending.

Adapted from
Mense, S. *The Pathogenesis of Muscle Pain.* Current Pain and Headache Reports 2003

Unique Neurobiology of Muscle Pain



Muscle pain is NOT skin pain

Muscle Pain is often Overlooked

THEN

"I'll be Back!"

NOW

"Ohhh, my Back!"

Muscle Pain

Peripheral Mechanisms Underlying Sensitization

Muscle Nociception – Binding of Substances to Matched Chemoreceptors

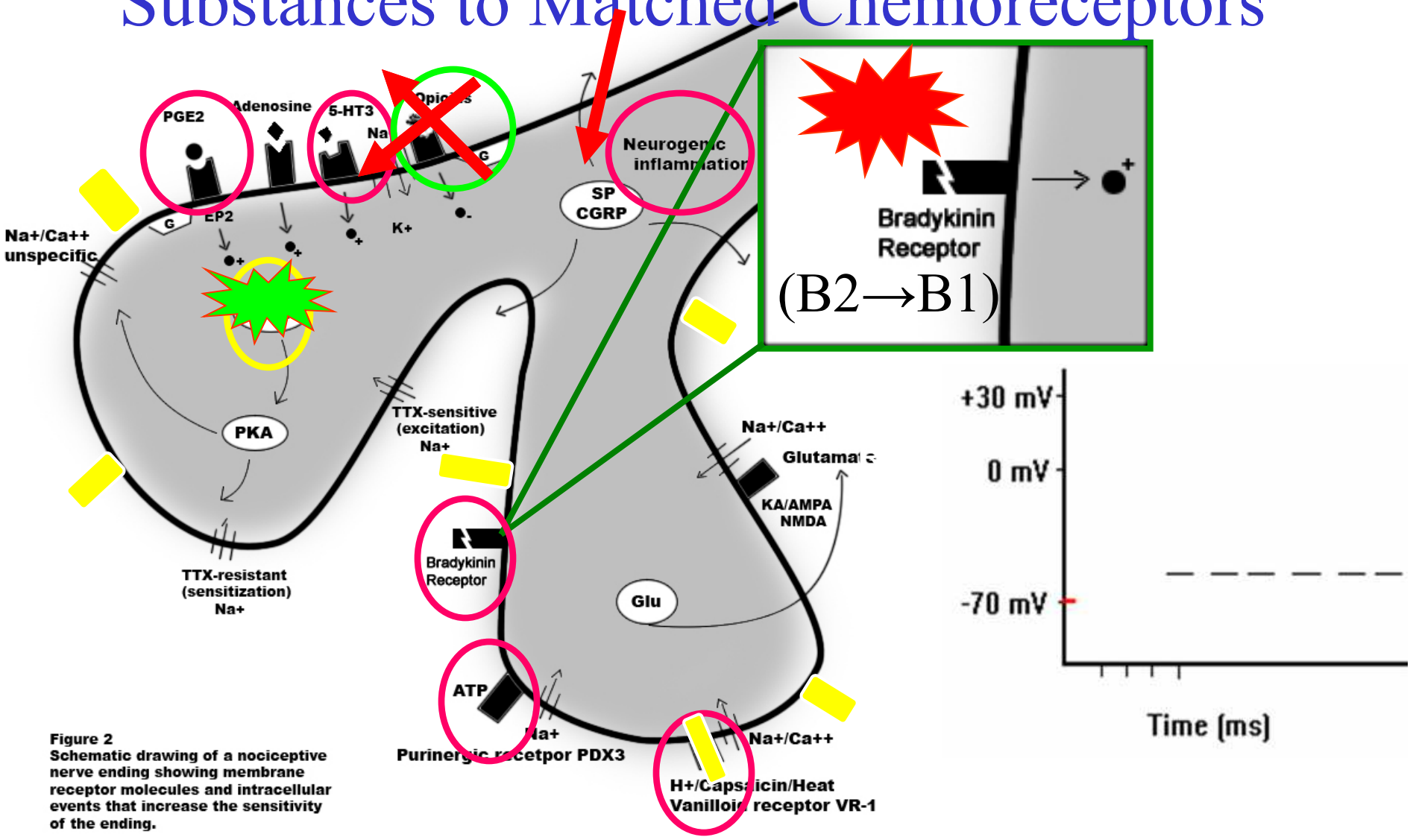


Figure 2
Schematic drawing of a nociceptive nerve ending showing membrane receptor molecules and intracellular events that increase the sensitivity of the ending.

Adapted from
Mense, S. *The Pathogenesis of Muscle Pain.* Current Pain and Headache Reports 2003

Muscle Nociception: Binding of Substances to Matched Receptors

Unique Characteristics of Muscle Pain

- *Aching, cramping* pain, difficult to localize and *referred* to deep and distant somatic tissues
- Muscle pain *activates unique cortical* structures

  Svensson P et al. Cerebral processing of acute skin and muscle pain in humans. J Neurophysiology July 1997; 78: 450-460.
- *Inhibited* more strongly by descending pain-modulating pathways

  XianMin Y, Mense S. Response Properties and descending control of rat dorsal horn neurons with deep receptive fields. *Neuroscience 1990; 39:823-831.*
- Activation of *muscle* nociceptors is much more *effective* at inducing *neuroplastic* changes in dorsal horn neurons

  Wall PD, Woolf CJ. *J Physiol* 1984 Nov;356:443-458.

Powerful Descending Inhibition on Muscle Pain

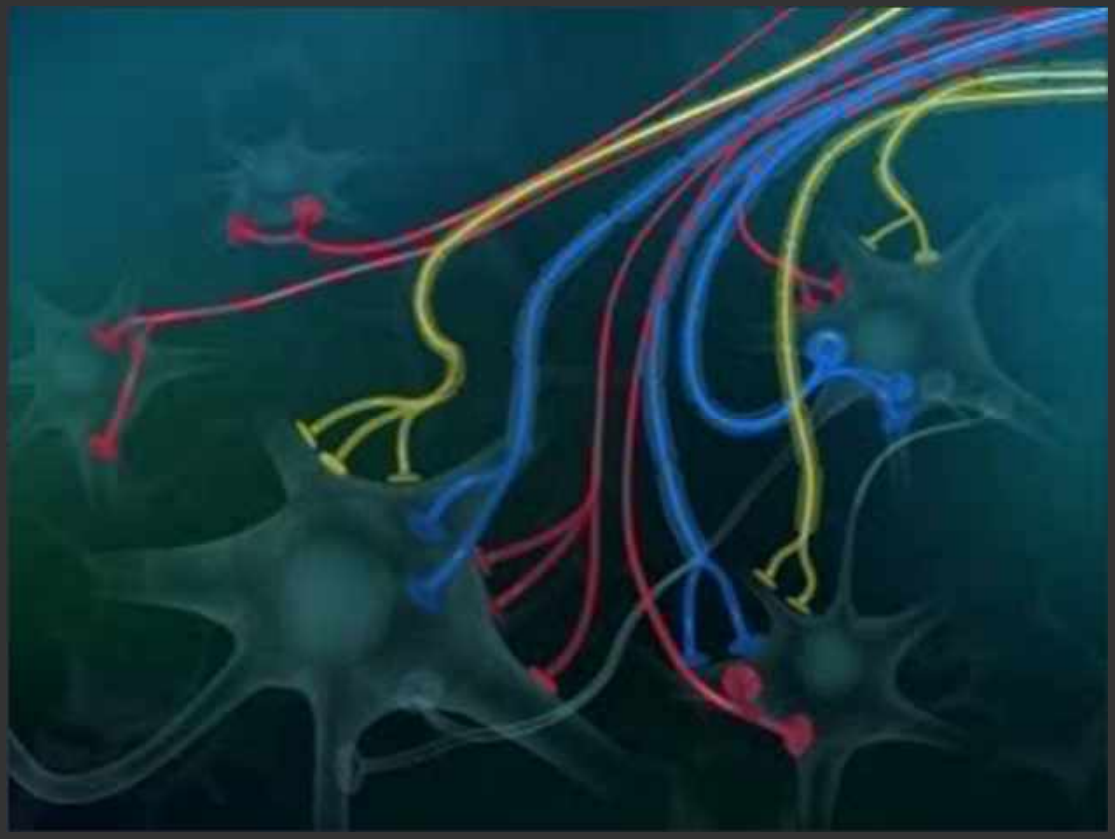
Fields HL, Basbaum AI: Central nervous system mechanisms of pain modualtion. In *Textbook of Pain*; 1999:309-329.

Muscle Pain

Spinal Mechanisms Underlying Expansion of the Receptive Field of Pain

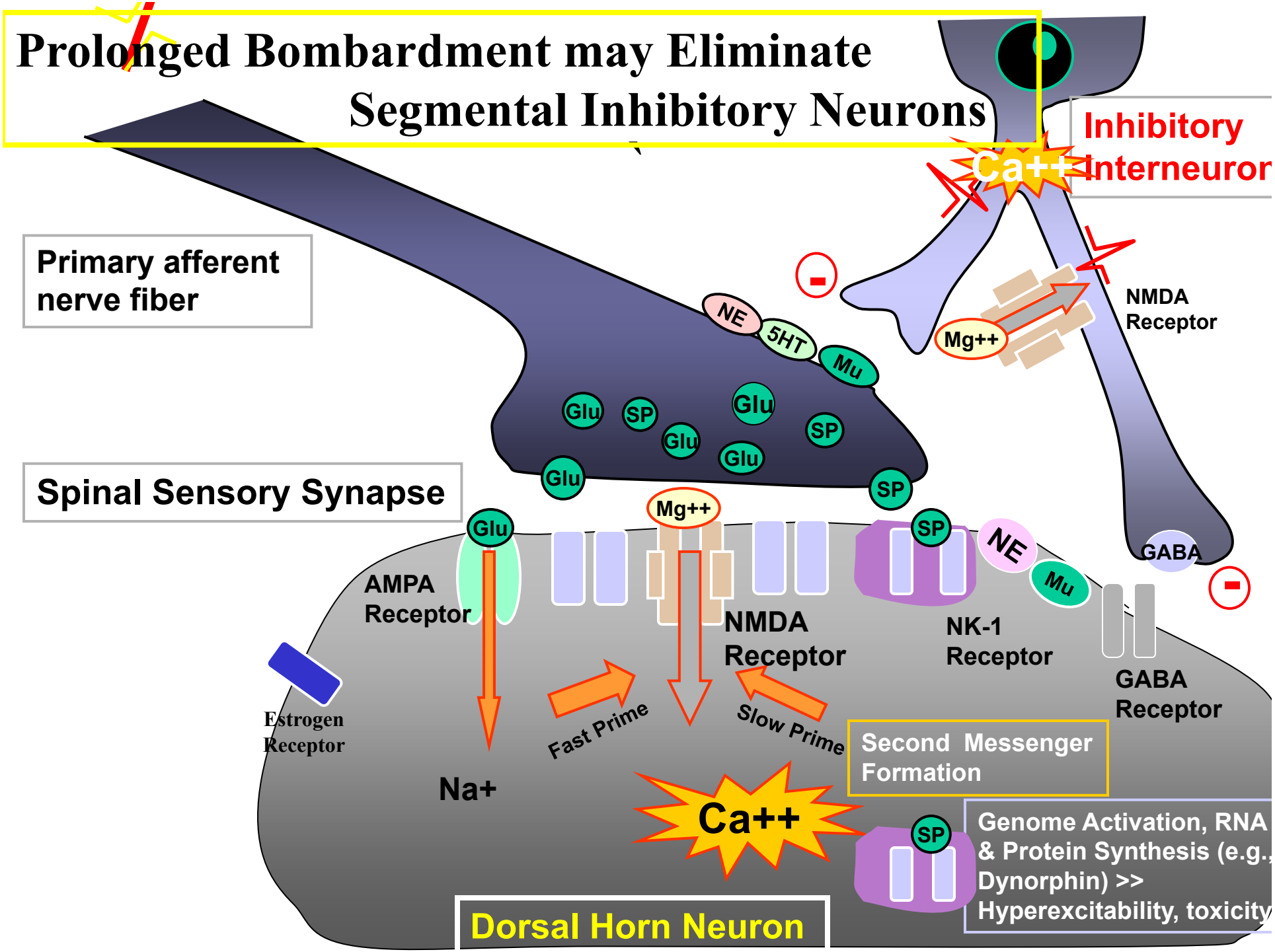
Activation of Muscle Nociceptors is much more Effective at Inducing Neuroplastic Changes in Dorsal Horn Neurons:

via Induction of Immediate Early Genes and Protein Synthesis, Excitotoxicity and Cell Death



Activity Dependent Plasticity

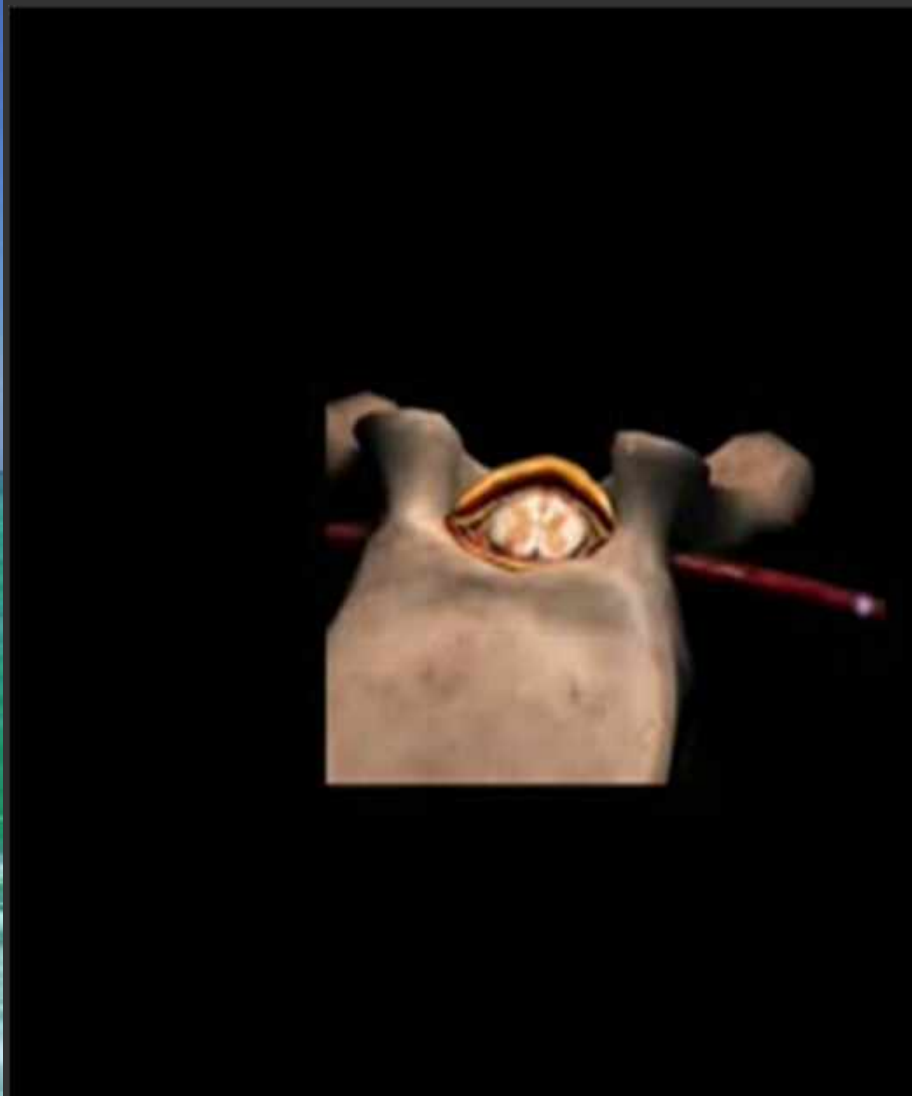
Wall PD, Woolf CJ. Muscle but not cutaneous C-afferent input produces prolonged increases in the excitability of the flexion reflex in the rat. J Physiol. 1984 Nov;356:443-58.


Prolonged Bombardment may Eliminate Segmental Inhibitory Neurons
Inhibitory Interneuron
Ca++
Primary afferent nerve fiber
NMDA Receptor
Mg++
NE
5HT
Mu
Glu
SP
Spinal Sensory Synapse
GABA
AMPA Receptor
NMDA Receptor
NK-1 Receptor
GABA Receptor
Estrogen Receptor
Na+
Fast Prime
Slow Prime
Second Messenger Formation
Genome Activation, RNA & Protein Synthesis (e.g., Dynorphin) >> Hyperexcitability, toxicity
Dorsal Horn Neuron

Nociceptive Bombardment causes

Central Sensitization and Neuroplastic

Changes in Dorsal Horn Neurons



Inhibitory Neurons block Nociceptive Bombardment

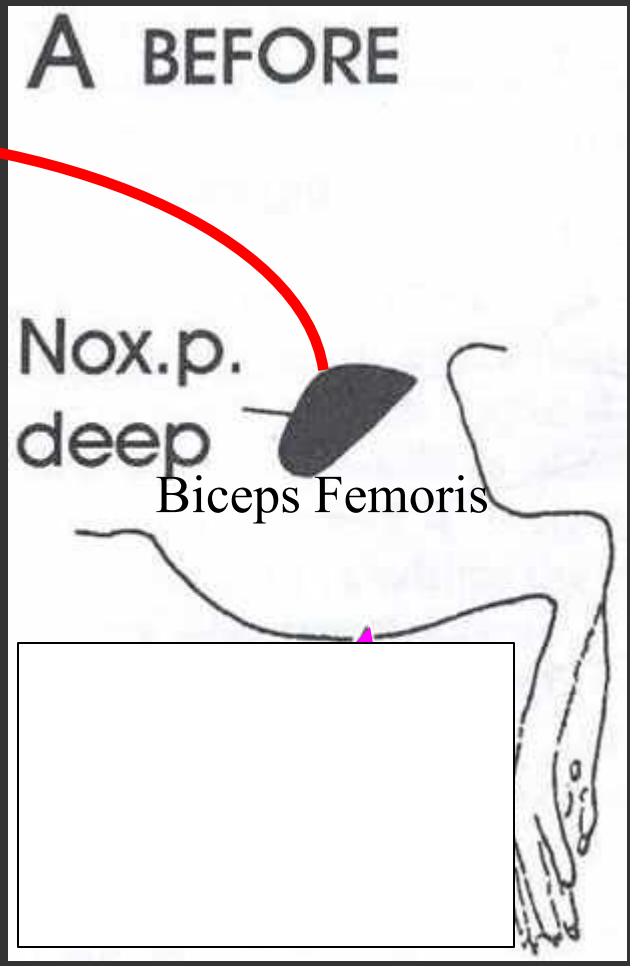
Nociceptive Bombardment causes

Central Sensitization and Neuroplastic

Changes in Dorsal Horn Neurons

Expansion of Receptive Field by a Painful Muscle Stimulus

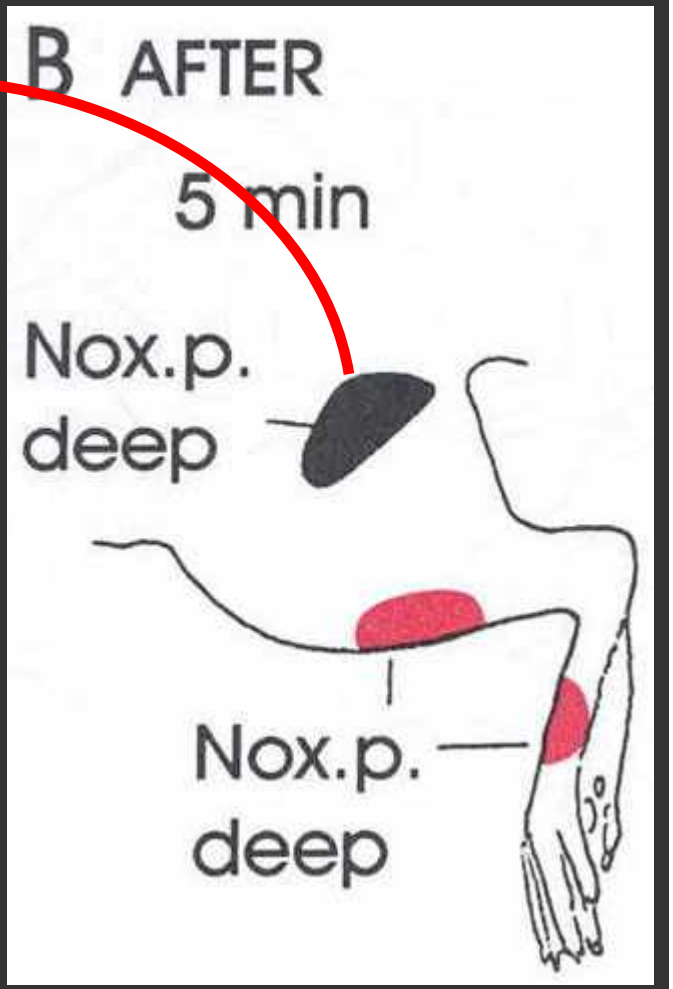
Courtesy Jan Dommerholt



Selected neuron responds only to deep pressure in biceps femoris muscle

Hoheisel U, Mense S, Simons DG. Appearance of new receptive fields in rat dorsal horn neurons following noxious stimulation of skeletal muscle: a model for referral of muscle pain? *Neurosci lett* 153:9-12, 1993

Expansion of Receptive Field by a Painful Muscle Stimulus

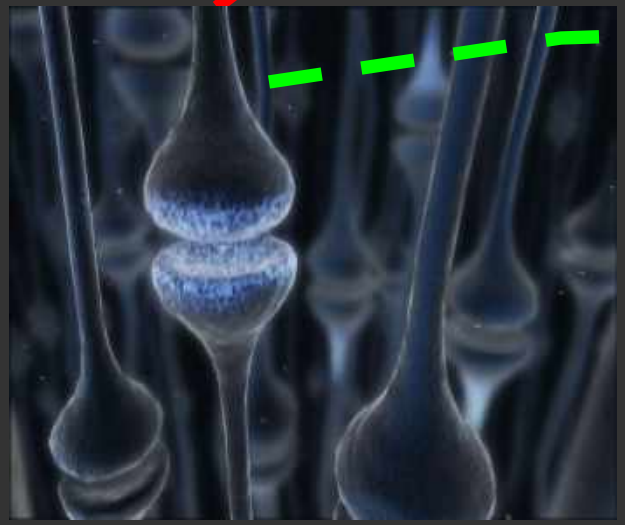


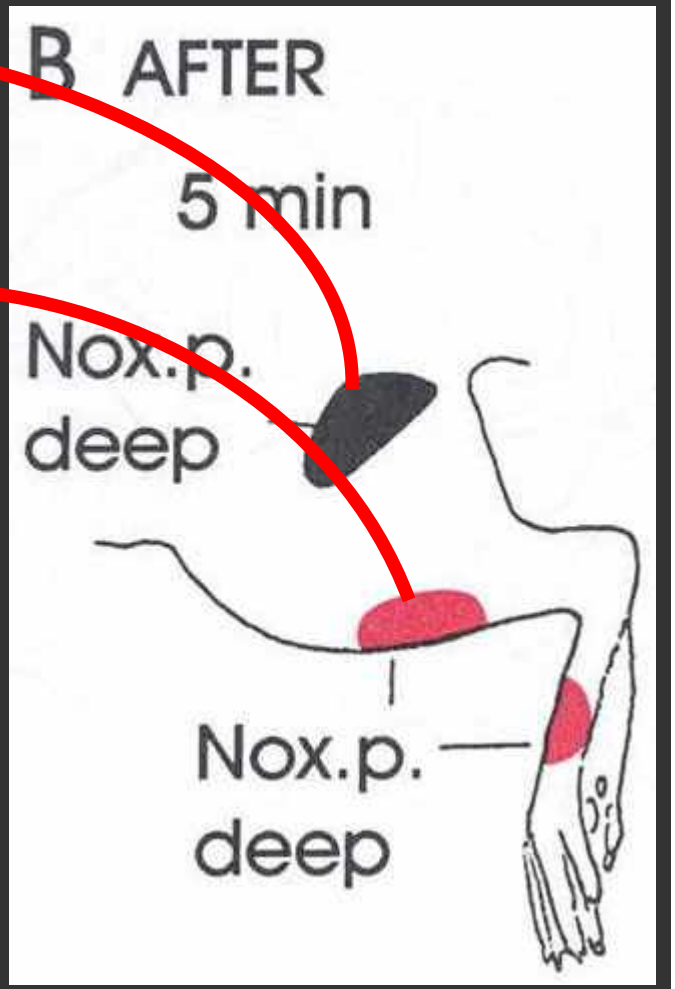
5 min after BK injection into the tibialis anterior, the selected neuron can now be excited by additional receptive fields located in deep muscle that normally have high threshold

Hoheisel U, Mense S, Simons DG.

Neurosci lett 153:9-12, 1993

Expansion of Receptive Field by a Painful Muscle Stimulus

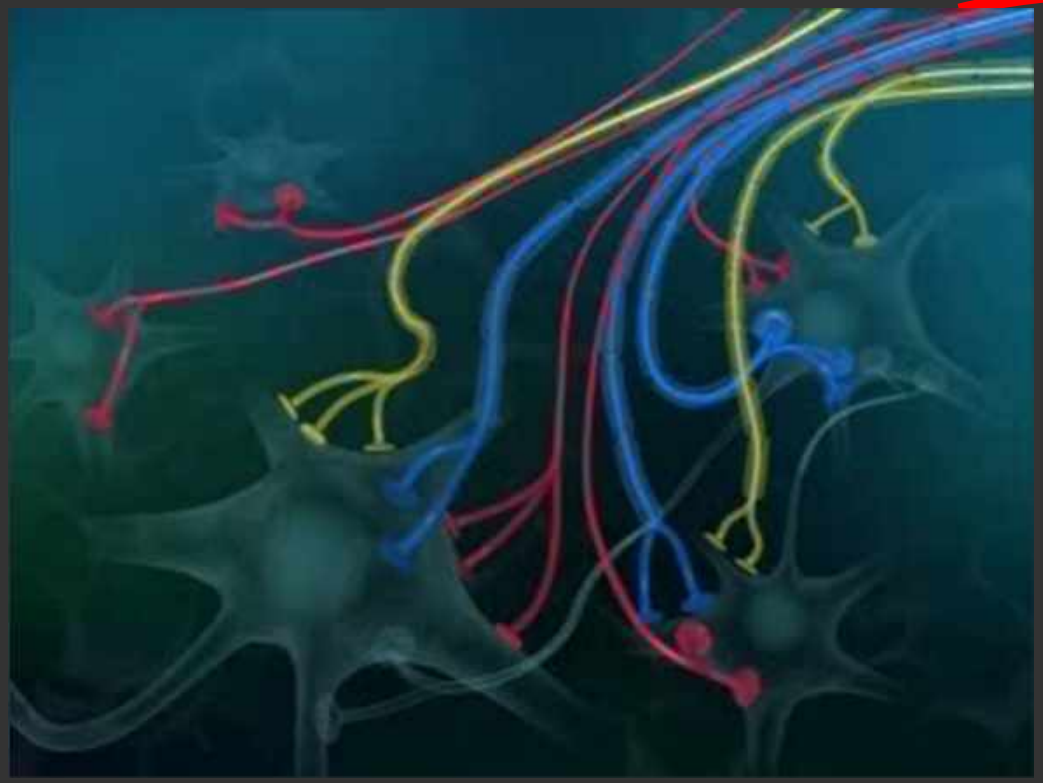


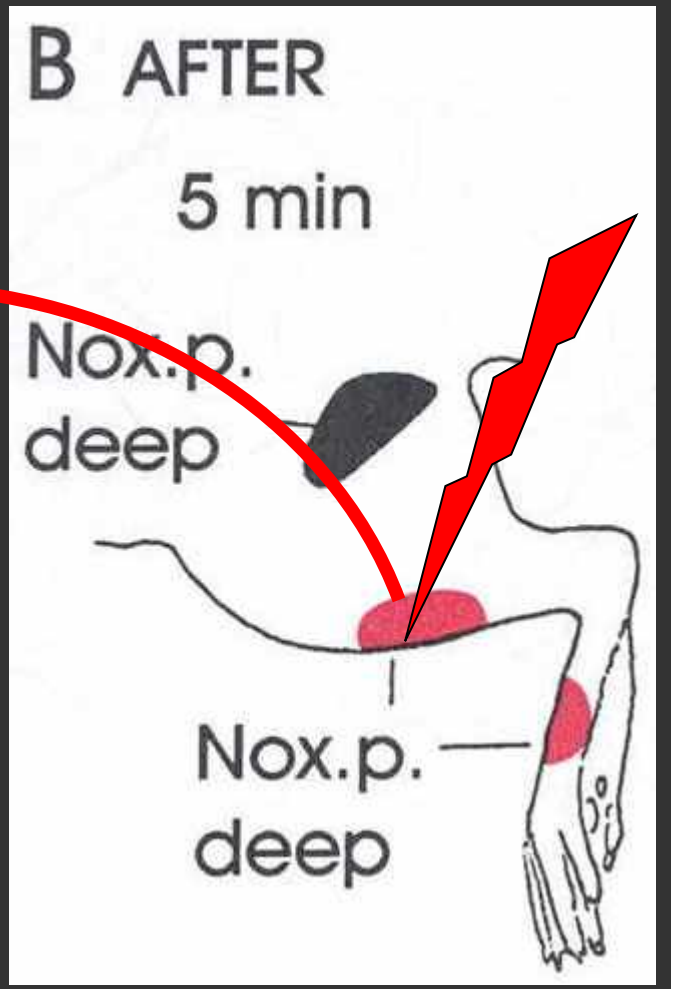


Hoheisel U, Mense S, Simons DG.

Neurosci lett 153:9-12, 1993

Expansion of Receptive Field by a Painful Muscle Stimulus

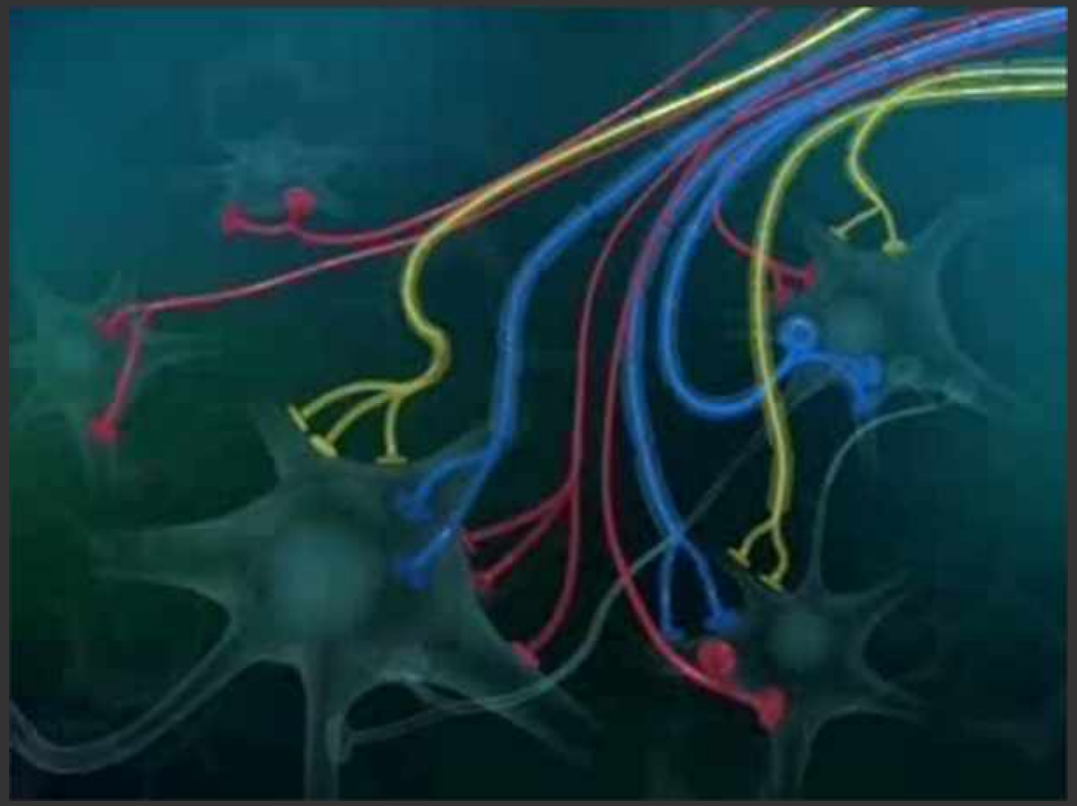


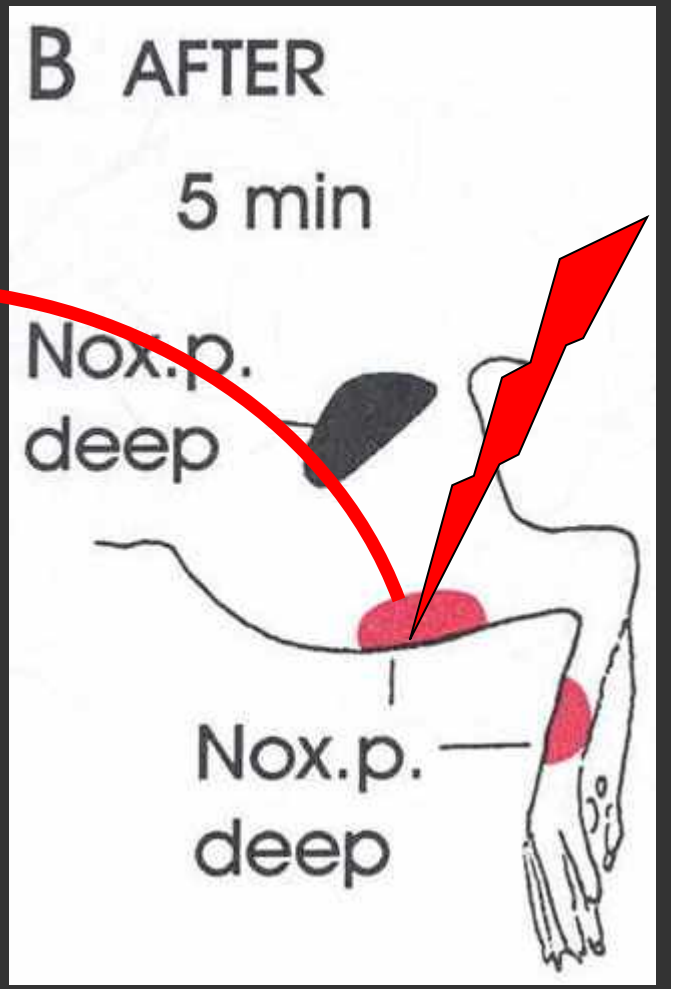


Hoheisel U, Mense S, Simons DG.

Neurosci lett 153:9-12, 1993

Expansion of Receptive Field by a Painful Muscle Stimulus

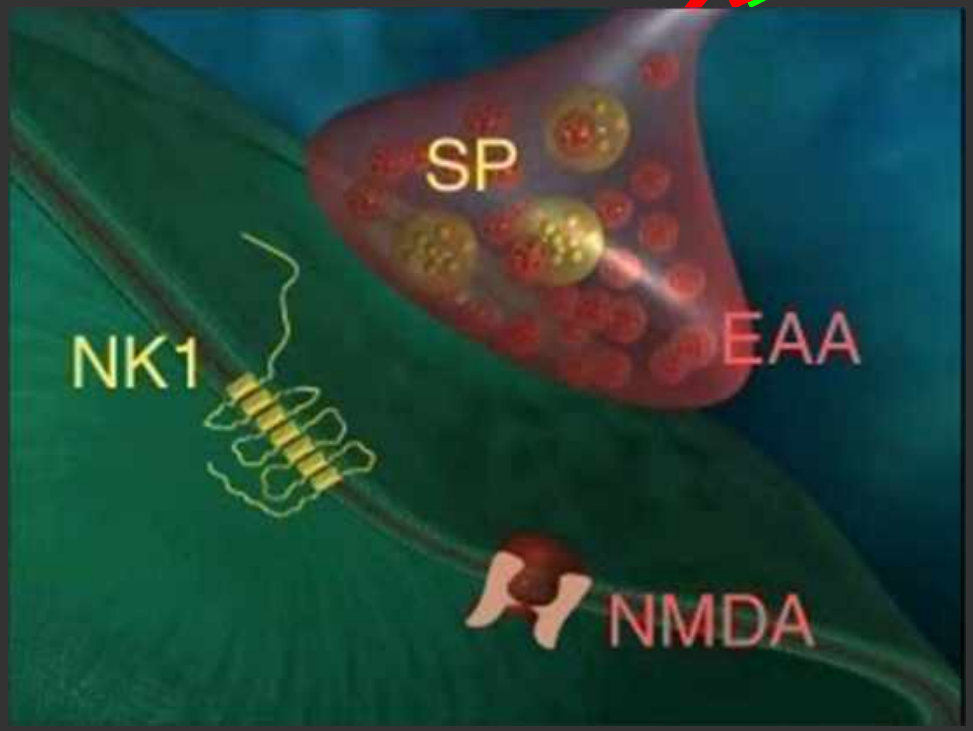


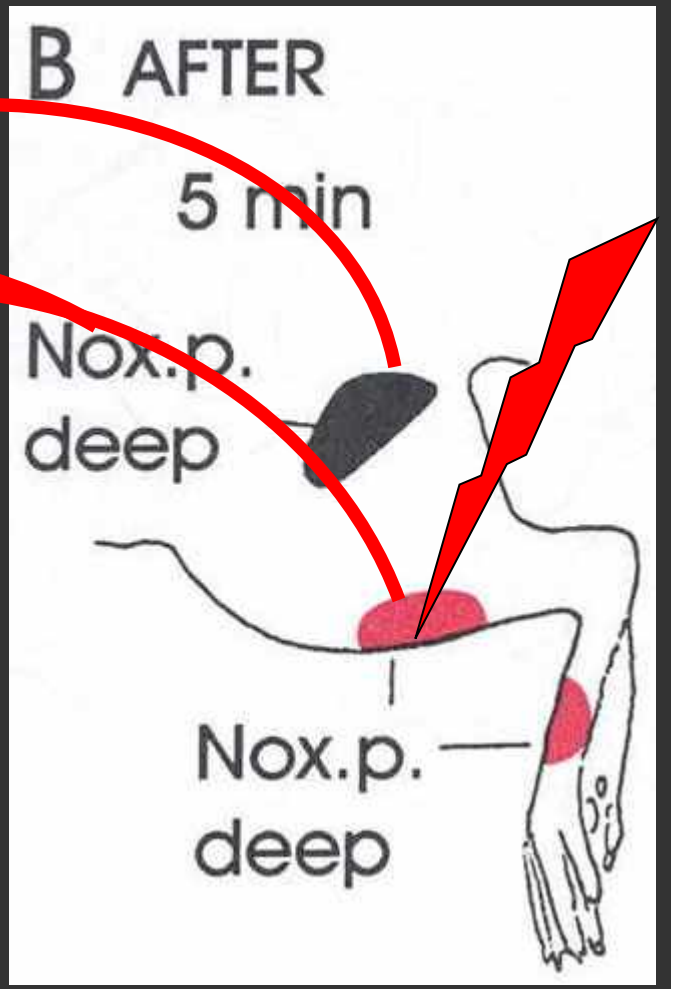


Hoheisel U, Mense S, Simons DG.

Neurosci lett 153:9-12, 1993

Painful Muscle Stimulus Opens Ineffective Synapses

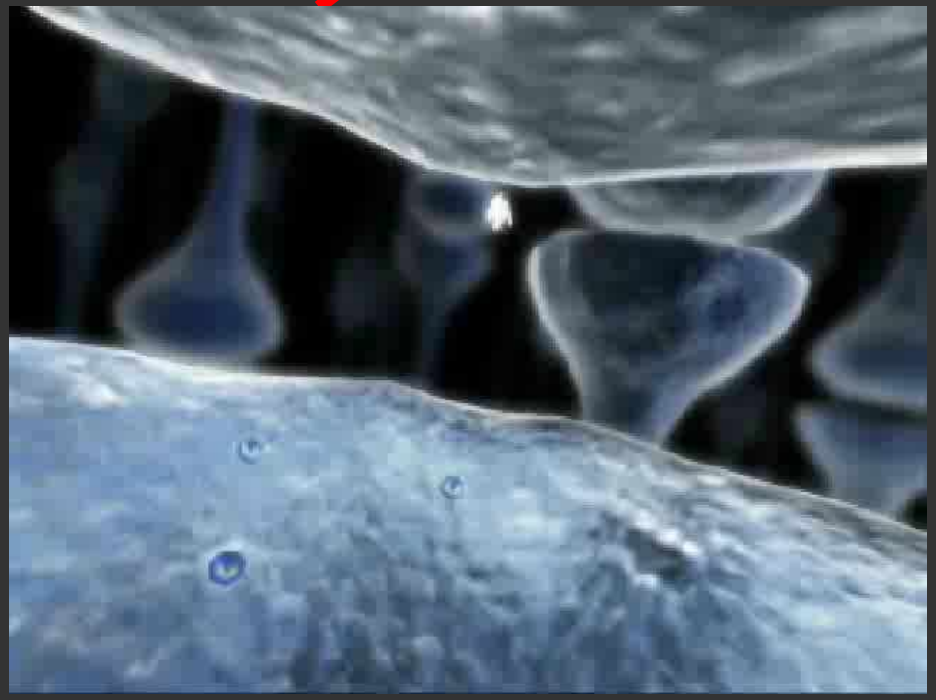


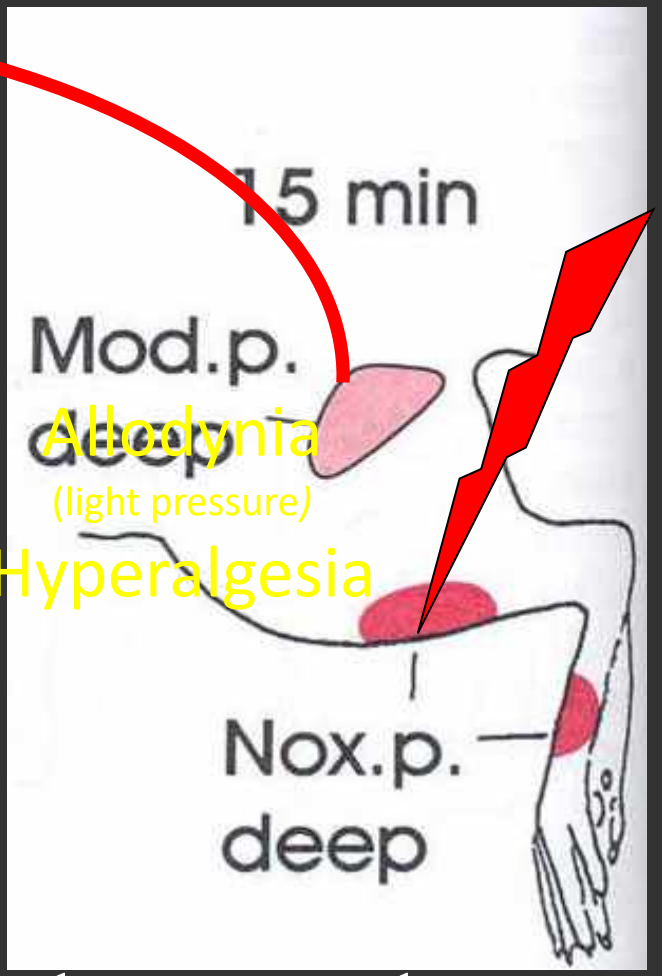


Hoheisel U, Mense S, Simons DG.

Neurosci lett 153:9-12, 1993

Expansion of Receptive Field by a Painful Muscle Stimulus

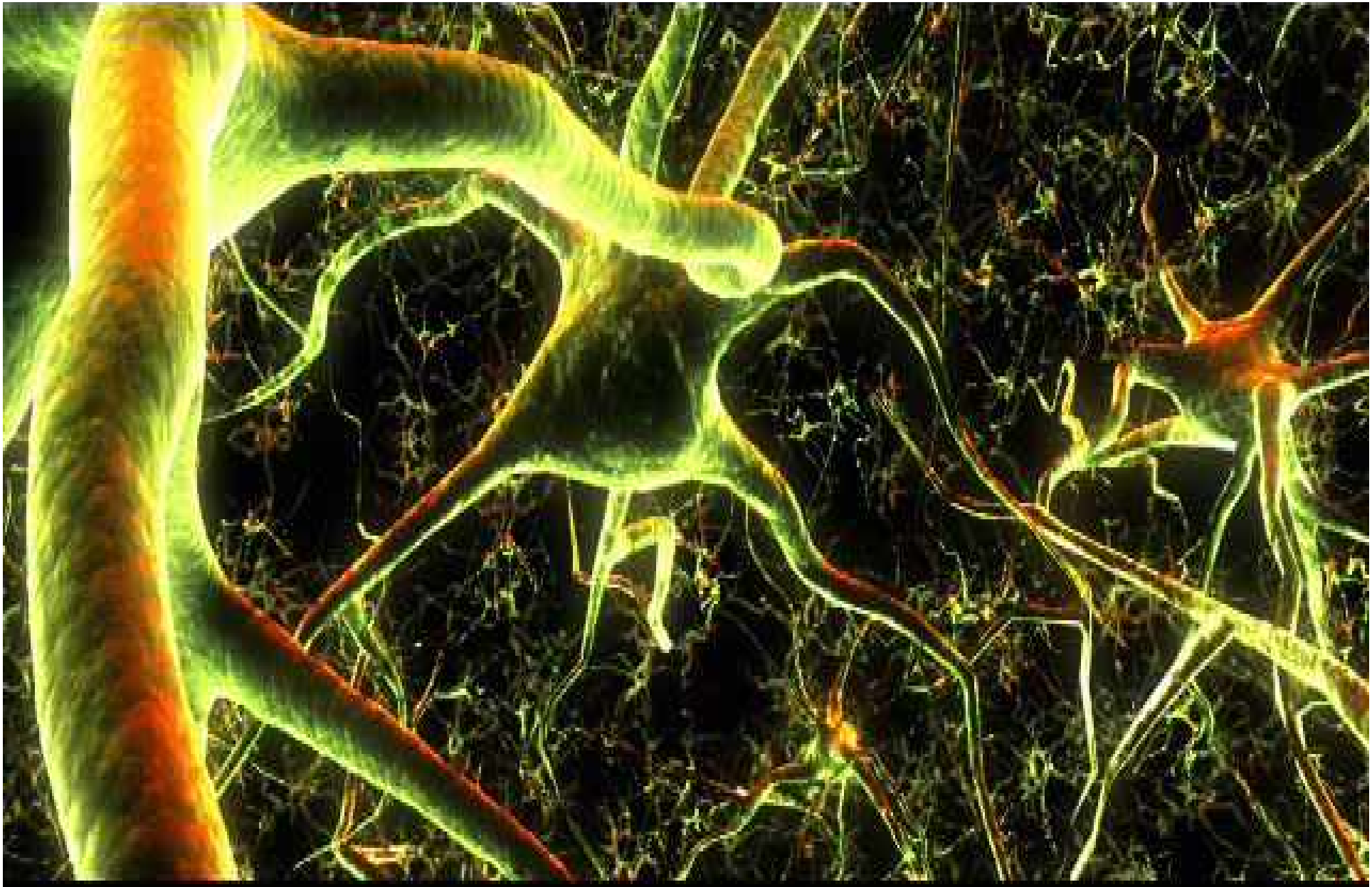




15 min after BK injection into the tibialis anterior the selected neuron responds to moderate (*innocuous*) pressure in its original receptive field of the biceps femoris muscle

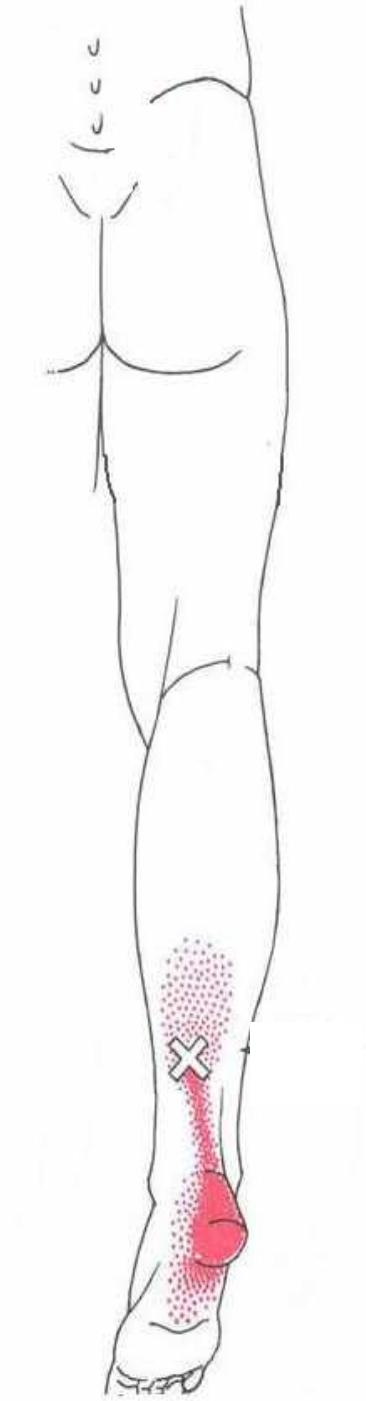
Hoheisel U, Mense S, Simons DG

Neurosci lett 153:9-12, 1993



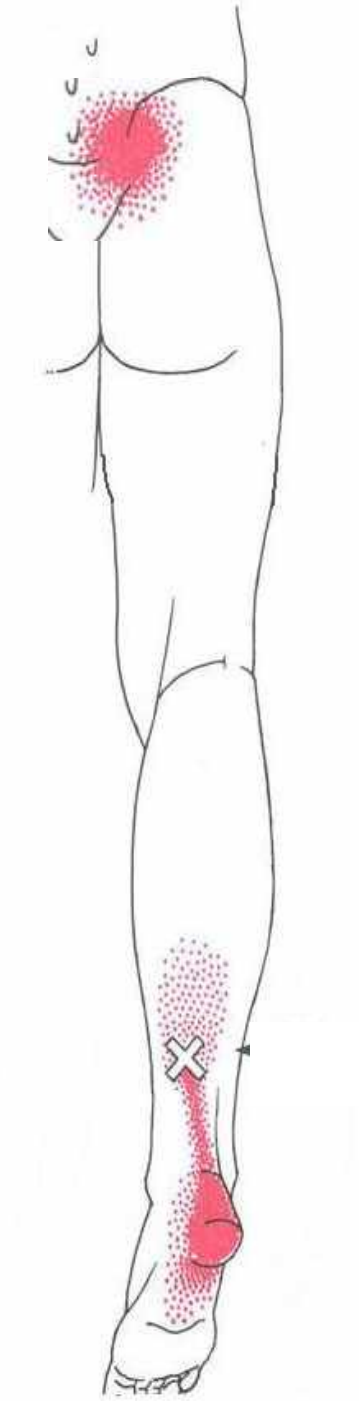
Ineffective Synapses can become Effective Synapses

Pain begins in Calf, Heel and Foot



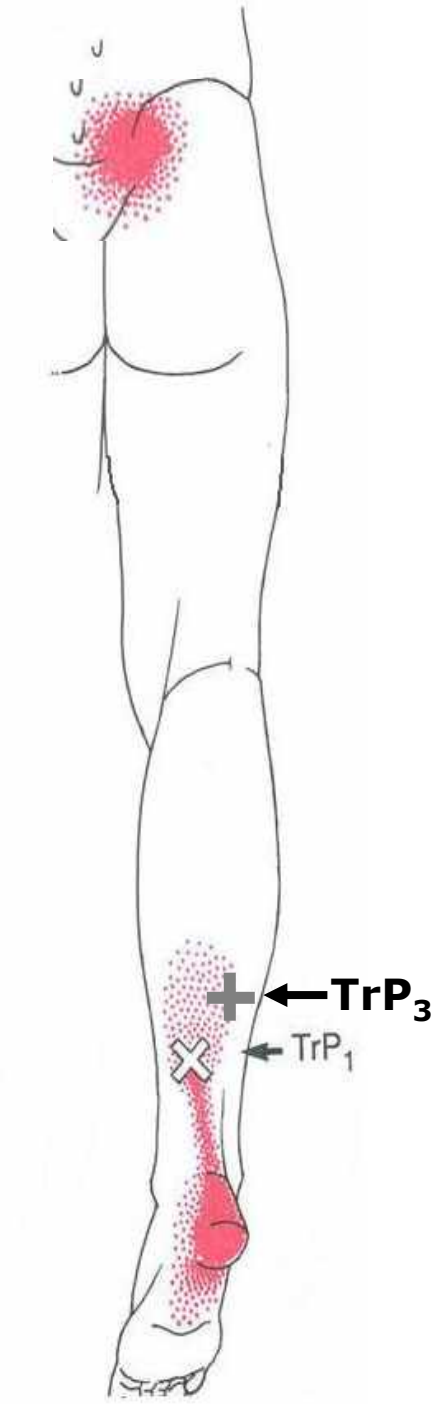
Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.

Then Develops Pain in Sacroiliac Joint too



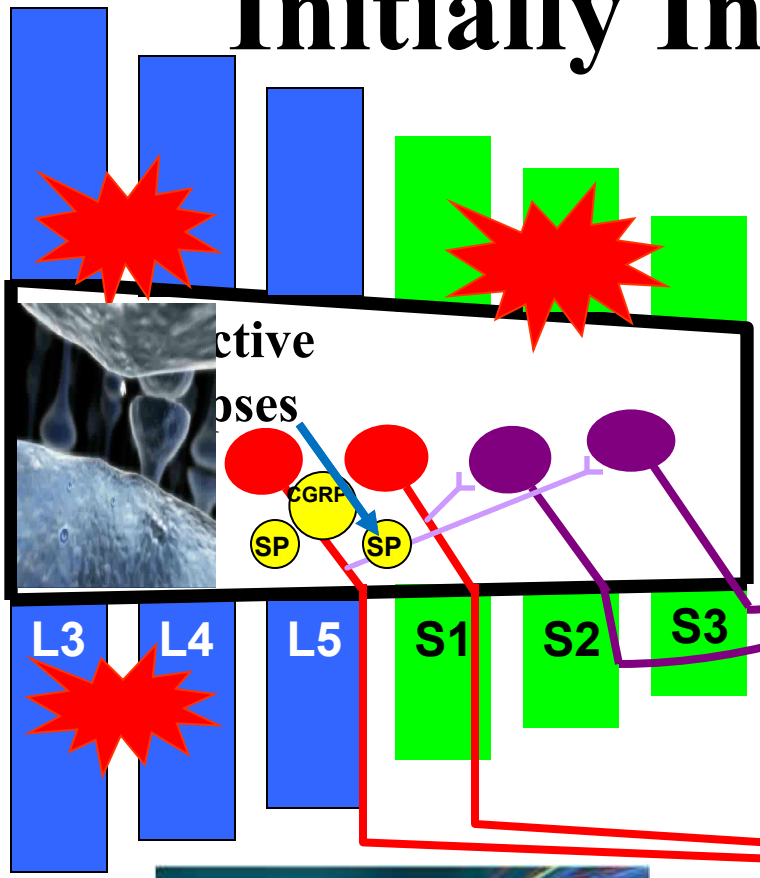
Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.

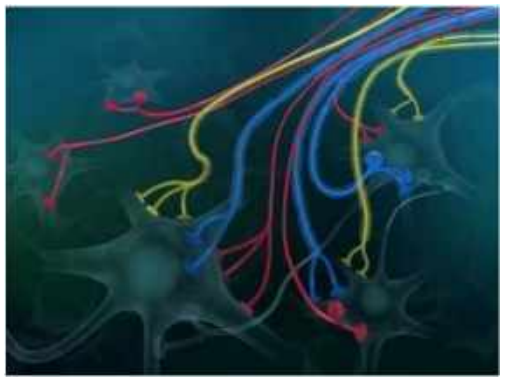
Then Develops Pain in Sacroiliac Joint too

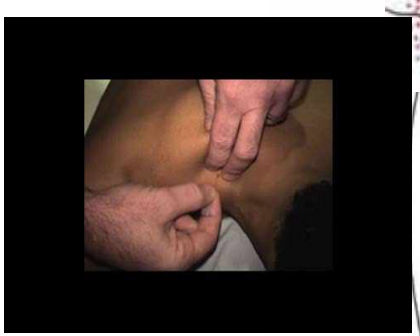


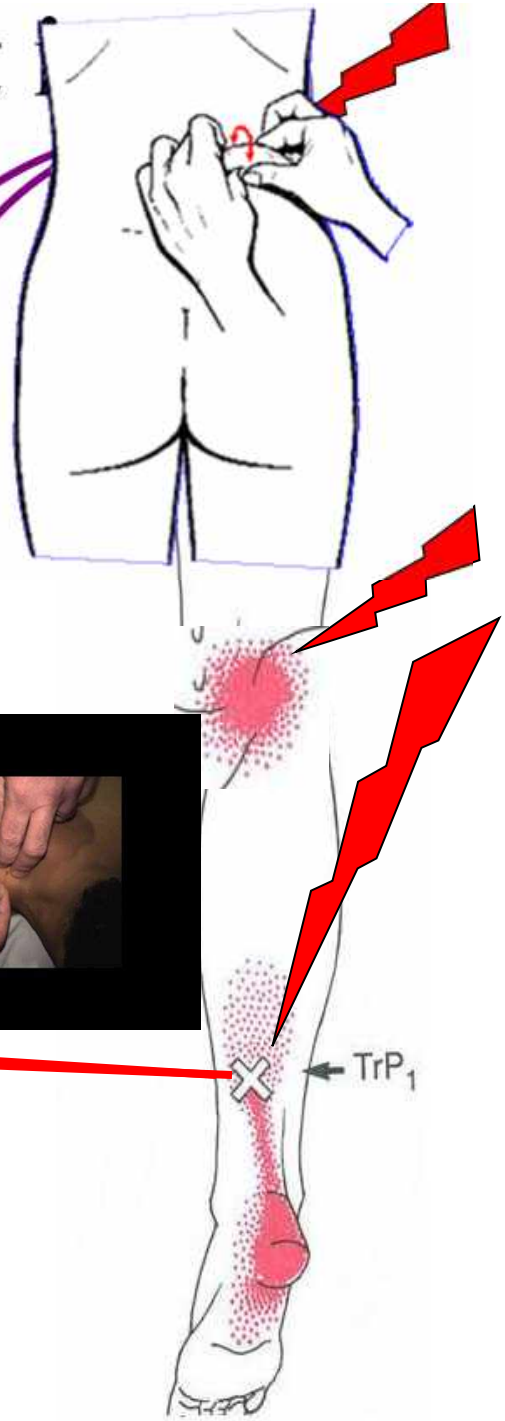
Travell JG, Simons DG. Myofascial pain and dysfunction: the trigger point manual. Baltimore: Williams & Wilkins; 1992.

Neuron for Sacroiliac Joint Initially Inactive





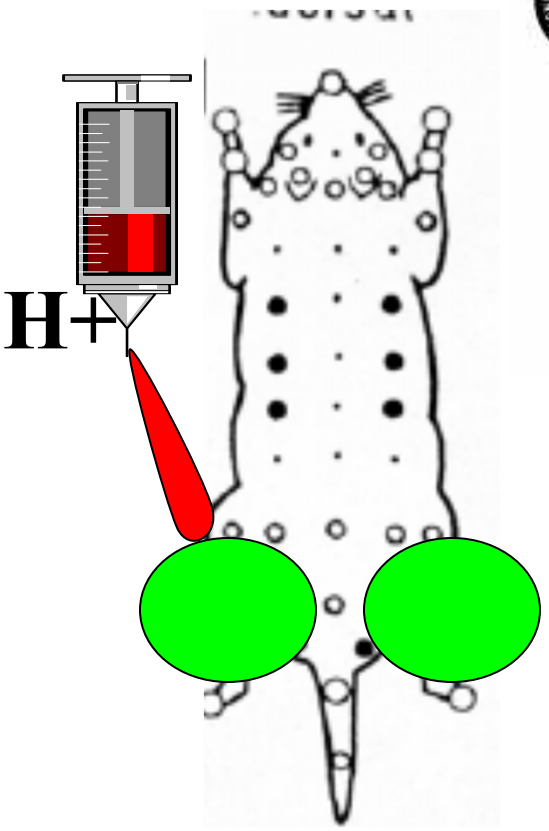




Biochemical Considerations of Sensitization

UNILATERAL INTRAMUSCULAR INJECTIONS OF ACIDIC SALINE PRODUCE A BILATERAL, LONG-LASTING HYPERALGESIA

K.A. SLUKA, PhD,[1,3] A. KALRA,[1] and S.A. MOORE, MD, PhD[2,3]



PAIN

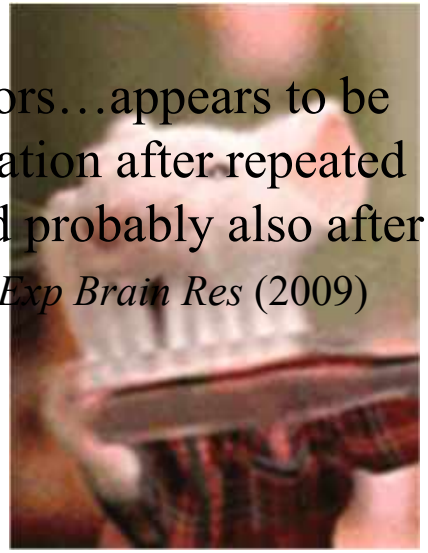
Pain 106 (2003) 229–239

www.elsevier.com/locate/pain

Chronic hyperalgesia induced by repeated acid injections in muscle is abolished by the loss of ASIC3, but not ASIC1

Kathleen A. Sluka[a,b,*], Margaret P. Price[c], Nicole M. Breese[d], Cheryl L. Stucky[d], John A. Wemmie[b,e,f], Michael J. Welsh[b,c]

"…activation of ASIC3 receptors…appears to be essential for the central sensitization after repeated injections of acidic solutions and probably also after other muscle lesions. Mense S. *Exp Brain Res* (2009)



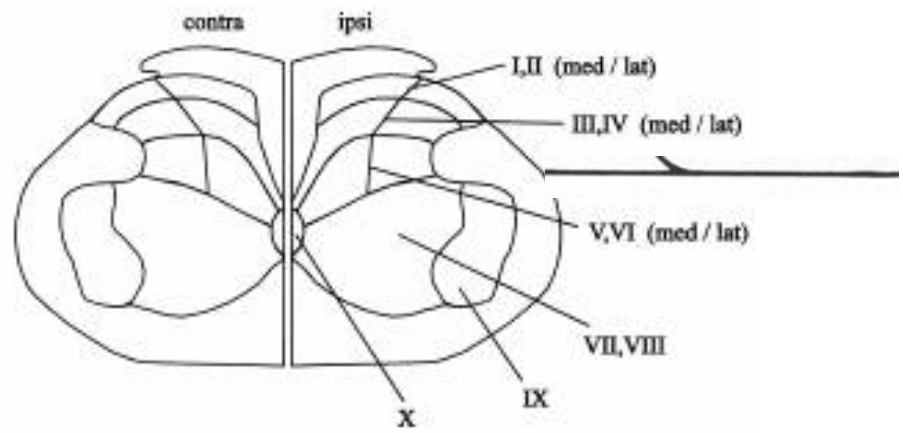
METABOLIC ACTIVITY CHANGES IN THE RAT SPINAL CORD DURING ADJUVANT MONOARTHRITIS

J. SCHADRACK,*†‡ F. L. NETO,*‡§ A. ABLEITNER,* J. M. CASTRO-LOPES,§ F. WILLOCH,*‖ P. BARTENSTEIN,‖ W. ZIEGLGÄNSBERGER* and T. R. TÖLLE¶

Complete Freunds Adjuvant versus saline in tibio tarsal joint

2- deoxyglucose technique:

Spinal Metabolic Activity



Neuroscience Vol. 94, No. 2, pp. 595–605, 1999

0306-4522/99 $20.00+0.00

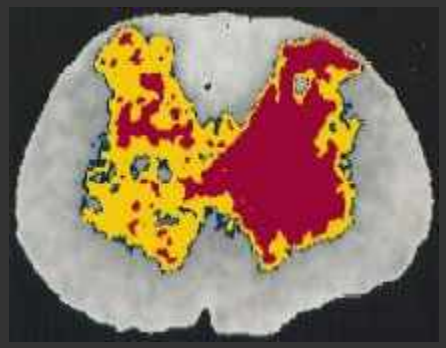
Spinal Metabolic Activity during Monoarthritis

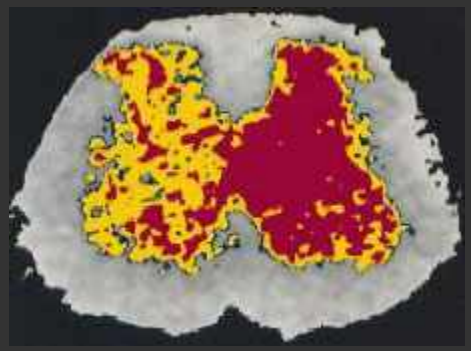
L2-L3

L4-L5

Saline

CFA





Neuroscience Vol. 94, No. 2, pp. 595–605, 1999

0306-4522/99 $20.00+0.00

“Seizure” of Dorsal Horn Neurons

Dynamic Changes in the Receptive Field of Pain

Substances *Dynamically* Modulating Dorsal Horn Neurons

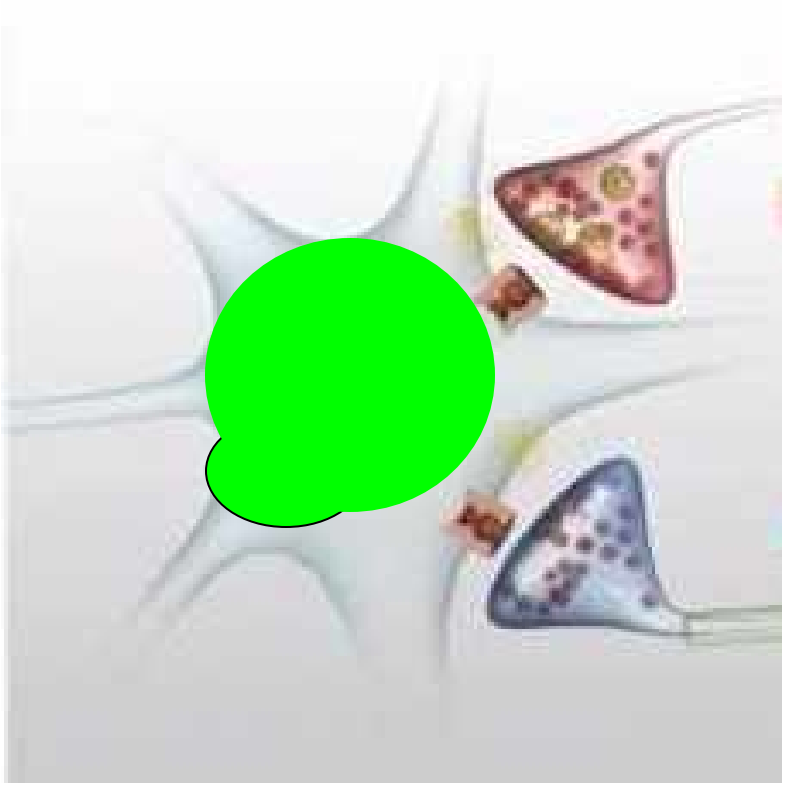
Immune system

Neurotrophins

Neurosteroids

Cytokines

Glia and Astrocytes



Dynorphin

Met Leu-enkepalin

SP

Galanin

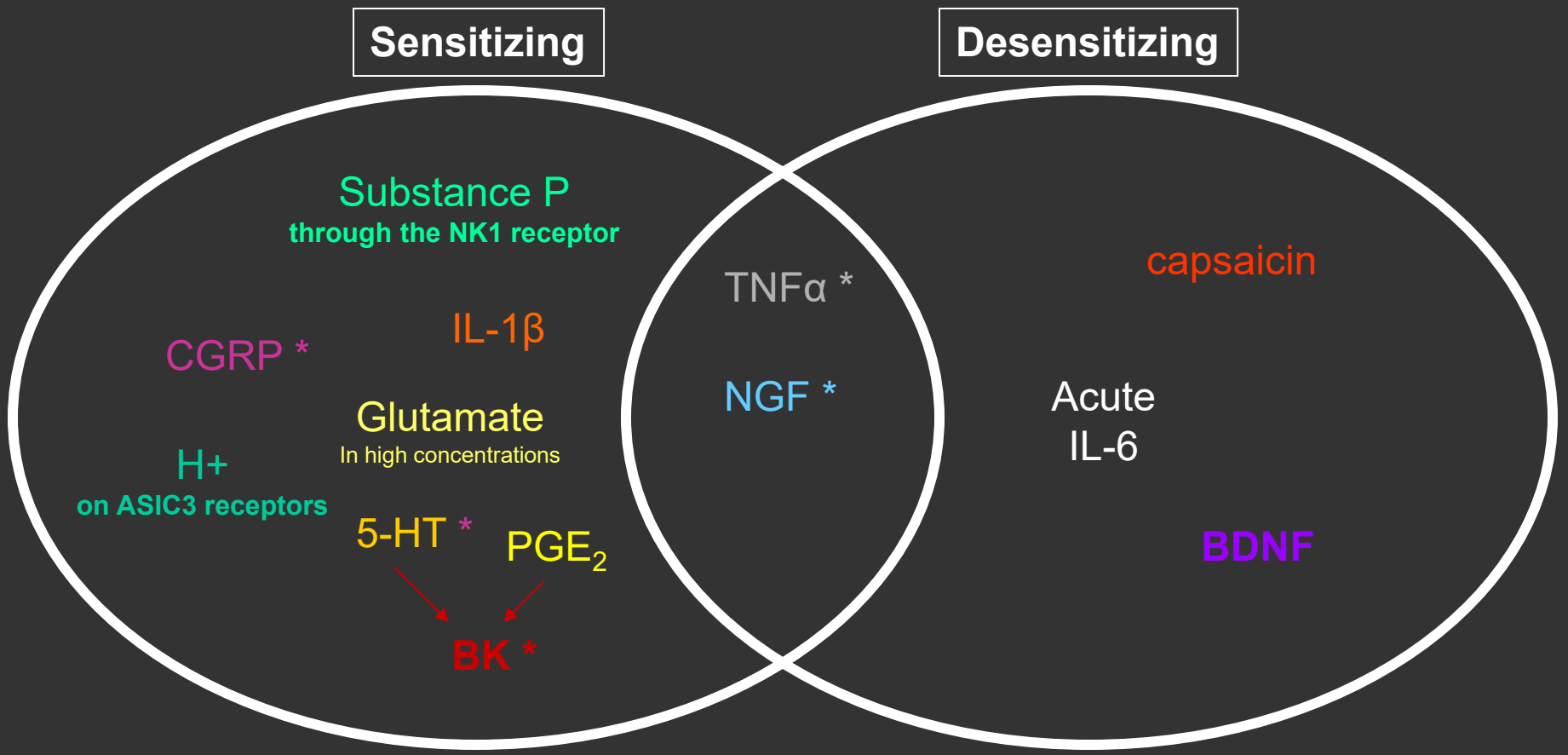
VIP

NPY

SOM

GABA, Glycine, Glutamate, ACh, DA, 5-HT, Nitric Oxide

Biochemicals and Sensitization



- * NGF works later (not acute)
- * TNFα plays a dual role (also related to acute vs. later phase sensitization)
- * PGE_2 and Serotonin (5-HT) work to augment Bradykinin (BK) induced sensitization
- * CGRP and 5-HT increase vasodilation and extravasation increasing other local sensitizing substances

PAIN

Pain 87 (2000) 253–259

Topical review

Dynorphin: friend or foe?

Robert M. Caudle[1,*], Andrew J. Mannes[2]

[1]Department of Oral Surgery, Division of Neuroscience, University of Florida College of Dentistry, P.O. Box 100416, Gainesville, FL 32610, USA
[2]Department of Anesthesia, University of Pennsylvania, Philadelphia, PA 19104, USA

Received 22 May 2000; accepted 20 June 2000

- Dynorphin activates opioid receptors but does not produce analgesia in the absence of injury
- Dynorphin activates NMDA receptors
- "…spinal dynorphin *first* preserves the animal through opiod receptors and then preserves the limb through NMDA receptors"
- Pathological damage may occur when dynorphin's animal and limb protective functions do not reduce nociceptive input and neuronal barrage

Journal of Bodywork and Movement Therapies (2008) 12, 371–384

ELSEVIER

Journal of
Bodywork and
Movement Therapies

www.elsevier.com/jbmt

MYOFASCIAL PAIN RESEARCH

Uncovering the biochemical milieu of myofascial trigger points using in vivo microdialysis: An application of muscle pain concepts to myofascial pain syndrome

Jay P. Shah, MD*, Elizabeth A. Gilliams, BA

Rehabilitation Medicine Department, Clinical Center, National Institutes of Health, 10 Center Drive, Room 1-1469, MSC 1604, Bethesda, MD 20892-1604 USA

Question

1. All of the following are main changes found in sensitized dorsal horn neurons *except:*

A) Increased responsiveness to external stimuli

B) Spread of excitation to spinal segments that do not normally receive input from the damaged muscle

C) Decreased background activity

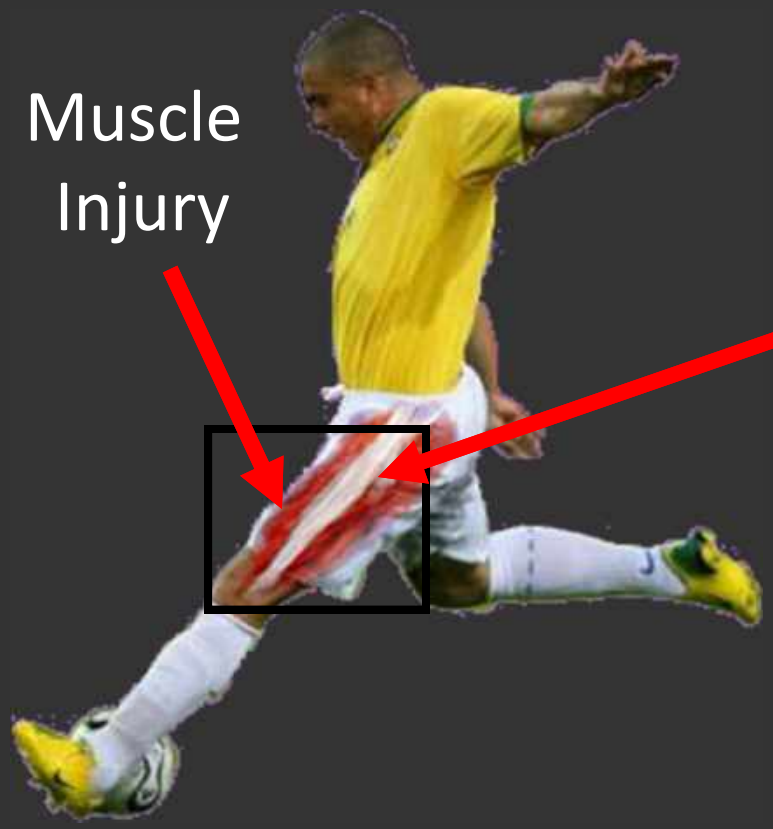
D) None of the above

Myofascial Trigger Points and the Unique Neurobiology of Muscle Pain:

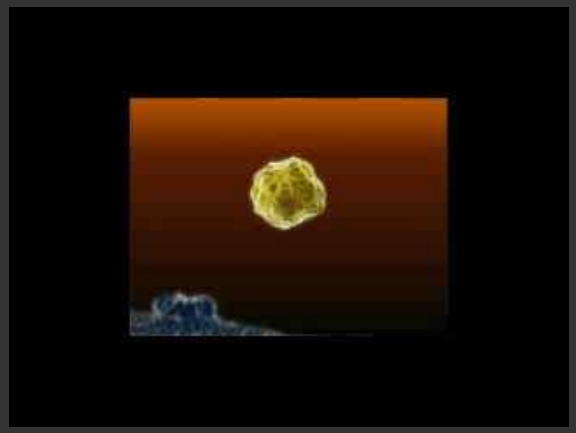
From Peripheral to Central Sensitization

Muscle Injury and Pain

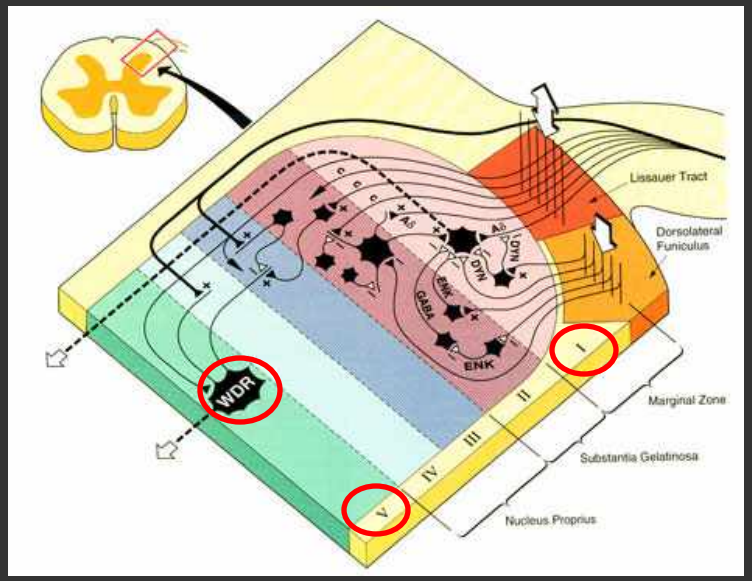
Muscle Pain, Inflammation, and Sensitization

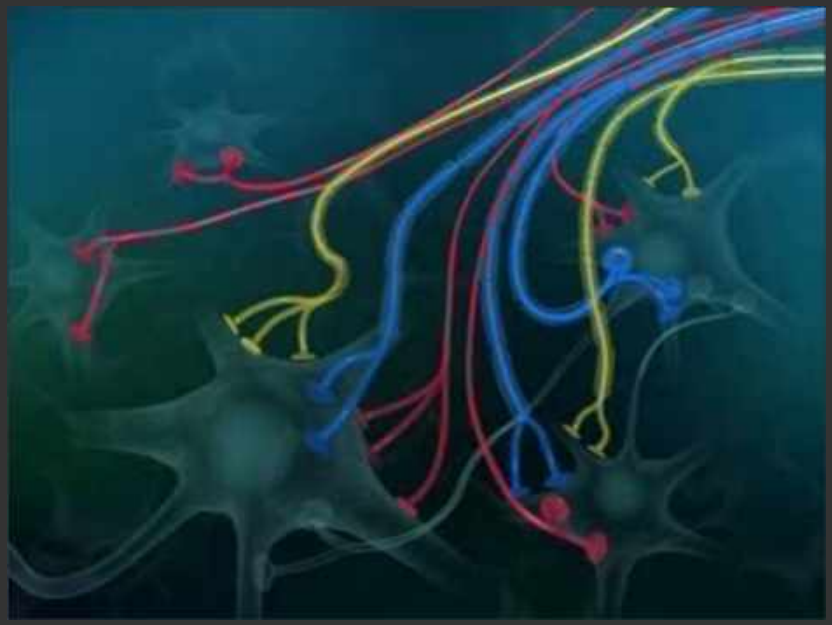


Release of Inflammatory mediators, Neuropeptides and Cytokines



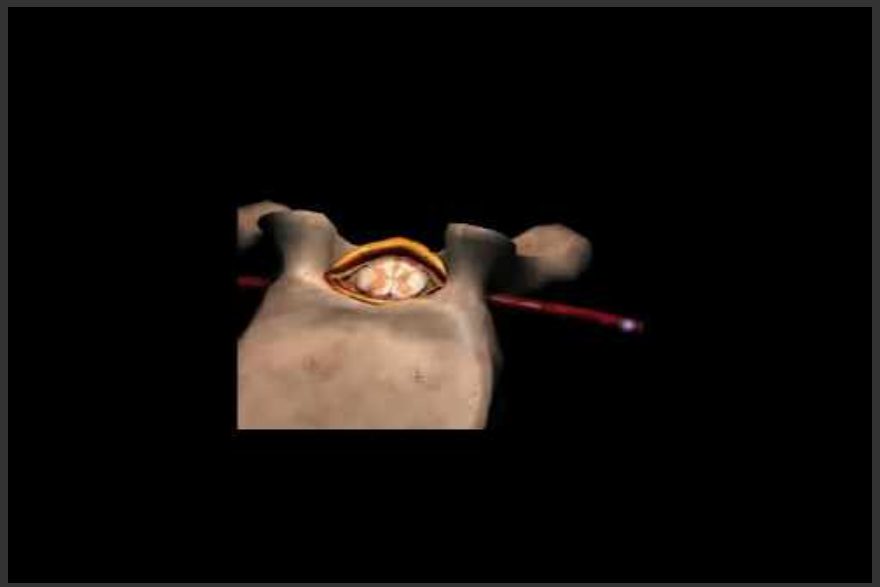
Muscle Pain, Inflammation, and Sensitization





Muscle Pain, Inflammation, and Sensitization

… expansion of the receptive field o
pain and referral of pain



Muscle Pain, Inflammation, and Sensitization

Limbic System → Increase: Fear, Anxiety, Stress

Muscle Injury

Pain Perception and the Human Brain

Niddam et al. found increased limbic system activity in upper trapezius myofascial pain syndrome

Niddam et al. The Clinical Journal of Pain, 2007

Descending Pain Pathway

Emotions

Hormones

Limbic System

Peri-Acqueductal Gray

Rostral Ventral Medulla:

ON/OFF Cells

Lamina I / V

Muscle re-injury, after premature return to sports or something else?

Sup

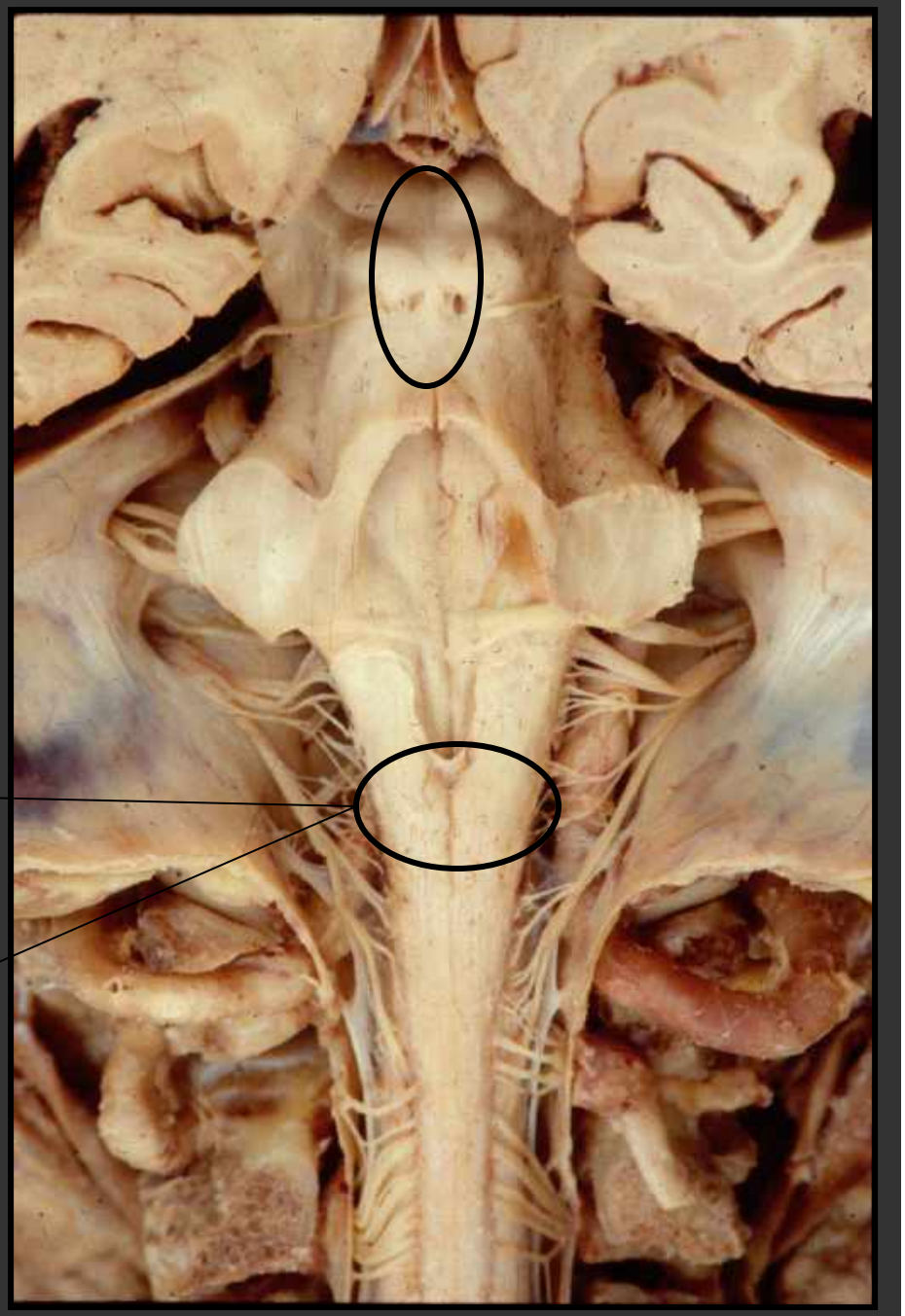
.

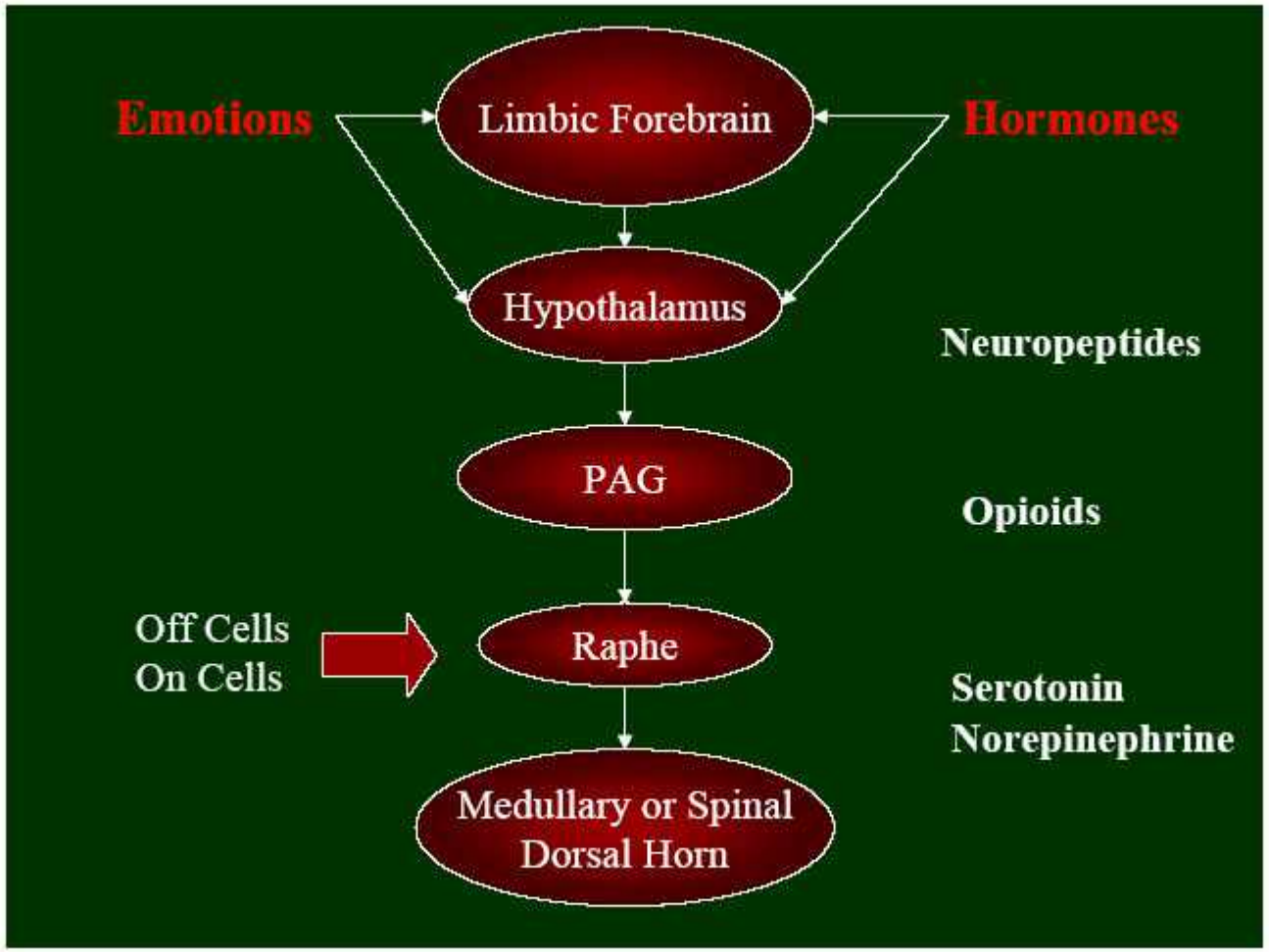
Periaqueductal Gray Raphe Nuclei

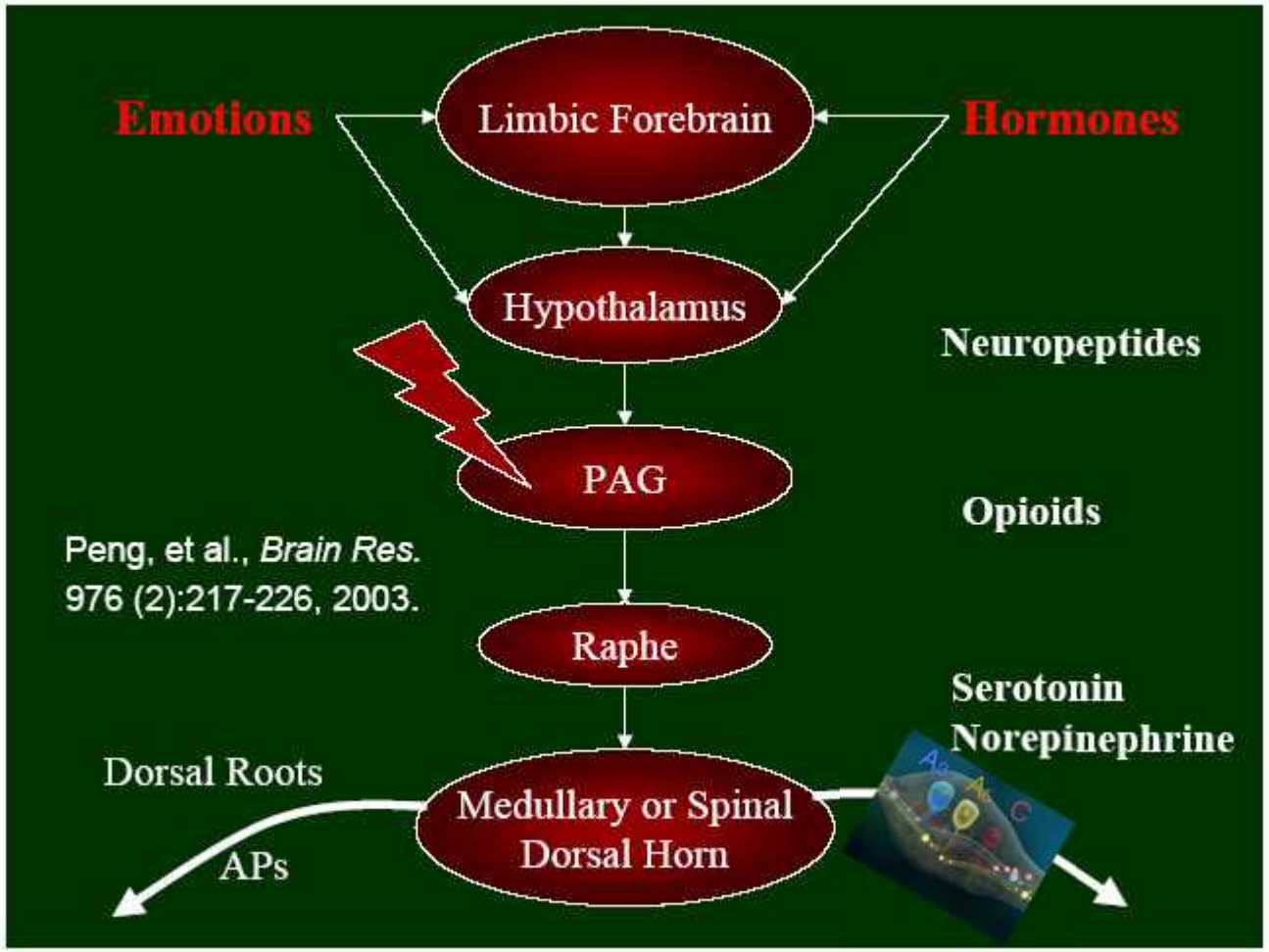
- Descending projections to the spinal cord gray matter

“Off Cells”

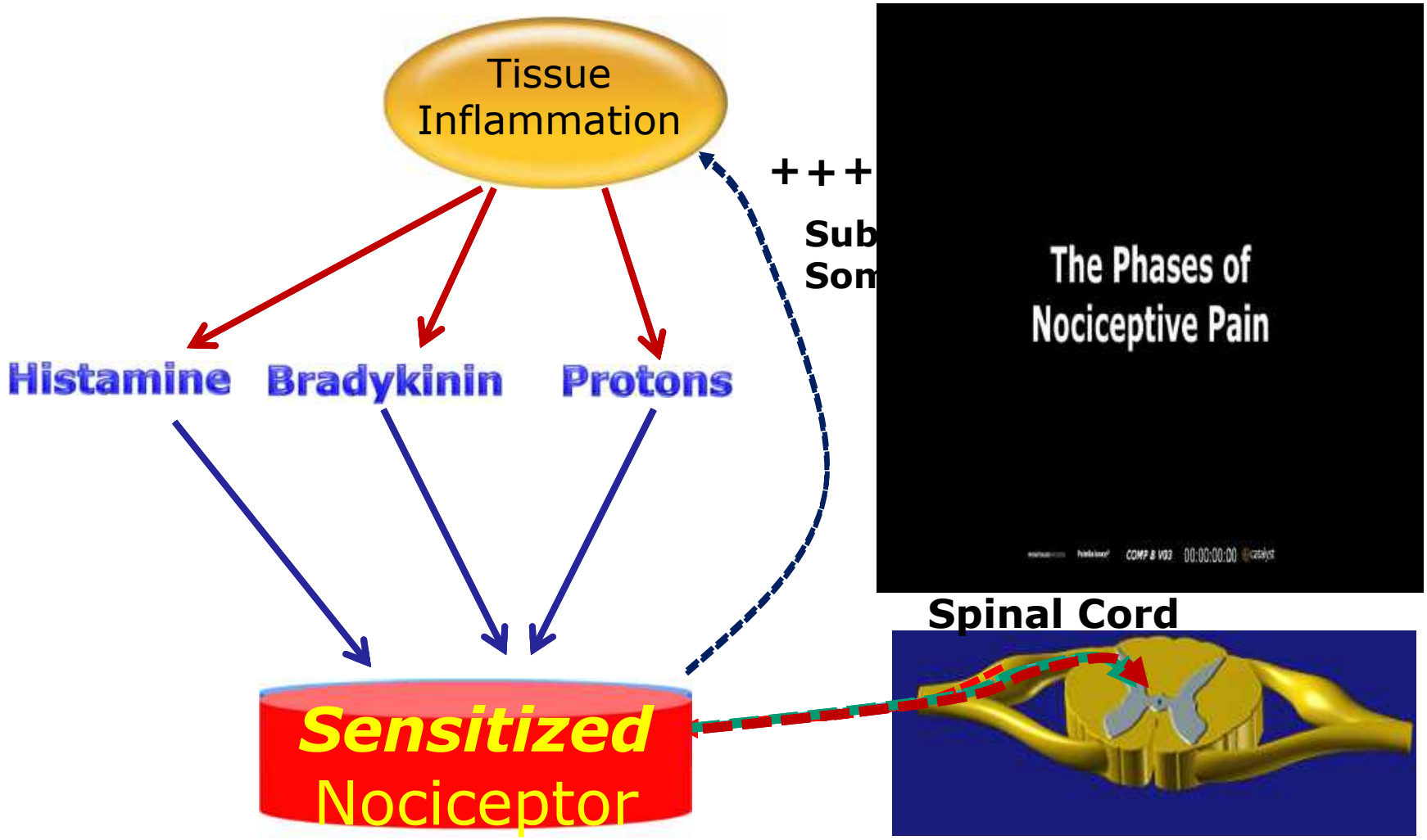
“On Cells”




Emotions
Limbic Forebrain
Hormones
Hypothalamus
Neuropeptides
PAG
Opioids
Off Cells
On Cells
Raphe
Serotonin
Norepinephrine
Medullary or Spinal
Dorsal Horn


Emotions
Limbic Forebrain
Hormones
Hypothalamus
Neuropeptides
PAG
Opioids
Peng, et al., Brain Res.
976 (2):217-226, 2003.
Raphe
Serotonin
Norepinephrine
Dorsal Roots
Medullary or Spinal
Dorsal Horn
APs

Neurogenic Inflammation and Dysfunctional Descending Modulation



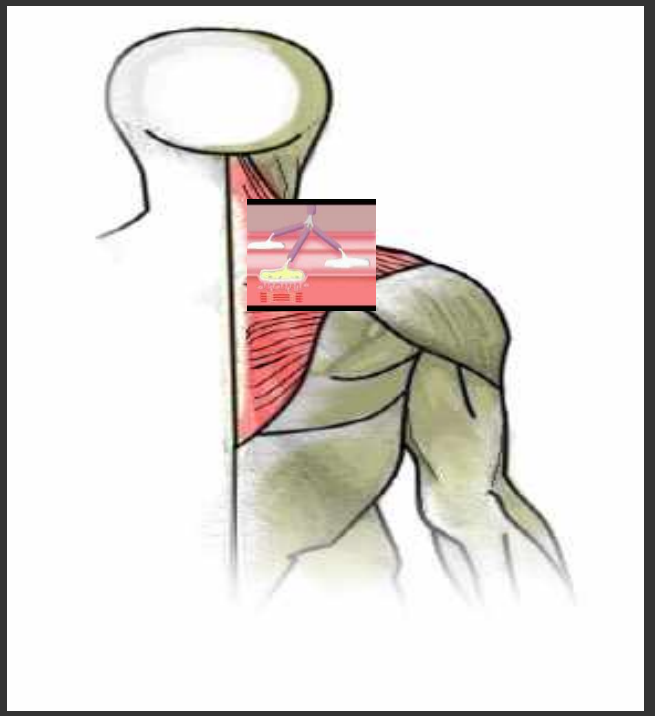
Courtesy Pedro Romero Ventosilla, MD

Myofascial Pain Syndrome:
A Clinical Conundrum

1) There is no accepted standard approach to the evaluation of Myofascial Pain Syndrome
2) The full impact of Myofascial Pain Syndrome on life activity and function is not fully understood
3) Many of the measures of pain currently in use are insensitive to change
4) We need a more comprehensive and systematic evaluation to distinguish people with MPS from those without

The Usefulness of the Cervical Range of Motion Device in the Ocular Motility Examination

Arch Ophthalmol. 2000;118(7):946-950. doi:10-1001/pubs.Ophthalmol.-ISSN-0003-9950-118-7-ecs90244



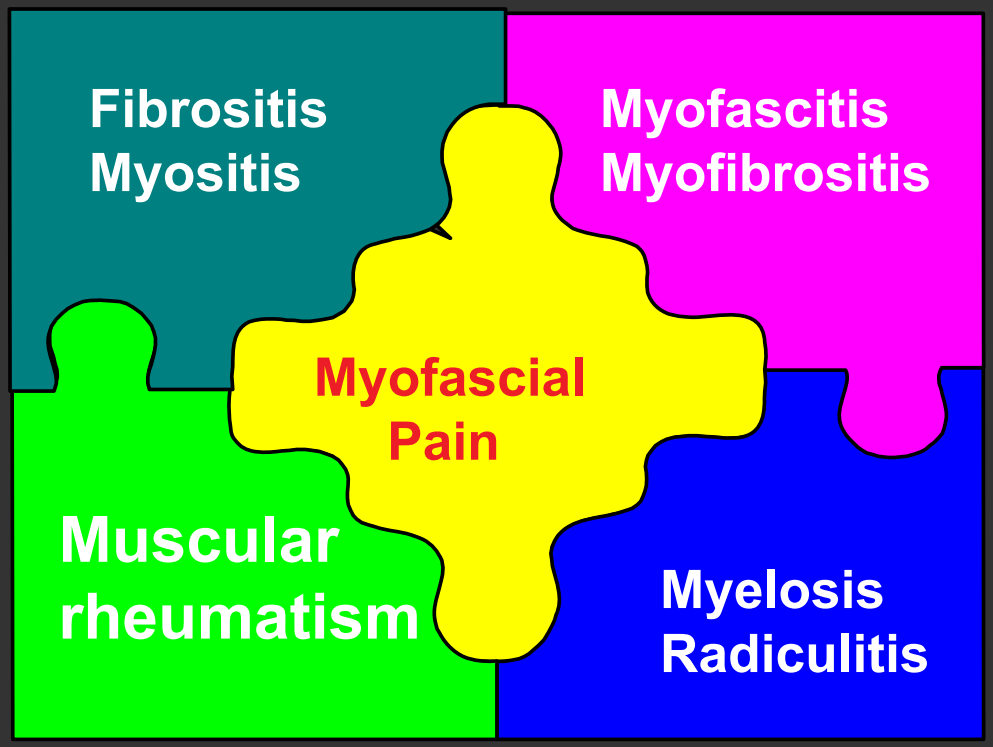
A Systematic Comparison b/w Subjects with no Pain and Pain associated with Active MTrPs

- A combination of objective measures (soft tissue palpation, CROM, algometry) and self-reports (SF-36, Profile of Mood States [POMS], Brief Pain Inventory [BPI], Oswestry Disability Scale) successfully distinguished subjects with cervical pain (due to *Active* MTrPs in upper trapezius) from subjects with no pain
- Compared to no pain group, the group with cervical pain secondary to *Active* MTrPs had:
- 1) Lower PPT ($p<0.01$)
- 2) Poorer health Status ($p<0.001$)
- 3) More depression, fatigue, tension, confusion and mood disturbance ($p<0.001$)
- 4) Greater disability ($p<0.0001$)
- 5) More restriction in side-bending ($p<0.01$)
- 6) More latent MTrPs ($p<0.001$)
- 7) More sleep disruption ($p<0.001$)

- Gerber L et al. *PMR* 2013

Myofascial Pain Syndrome (MPS)

Historical and Regional Confusion



"Since no (Medical) Specialty Claims Skeletal Muscle as it's Organ, it is Often Overlooked"

David G. Simons, MD

1922-2010

Muscle – The "Orphan Organ"

- NO specialty claims muscle as its organ
  - Muscle is ½ of the body
  - No organized emphasis on muscle pain (MTrP) research or student training
  - Clinicians focus primarily on treating the SYMPTOMS of myogenic pain, not the CAUSE of the pain (MTrPs)

Muscle Palpation is a Learned Skill – Start Early!

Travell and Simons' Trigger Point Manual

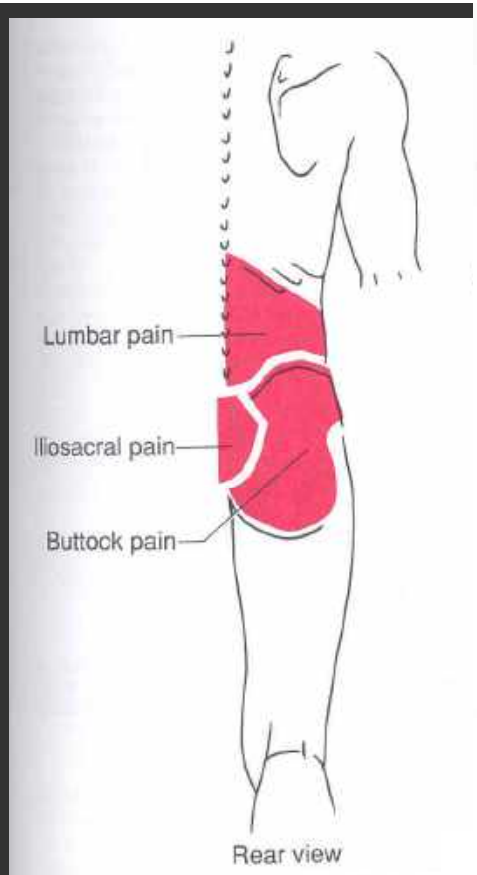


Figure 3.1. Designated areas *(red)* within the low torso region where patients may describe myofasc pain. The pain may be referred to each designated

PAIN GUIDE

ABDOMINAL PAIN

Rectus abdominis (49.2*B*, p. 664)[9]
Obliquus externus abdominis (49.1*C*, p. 662)[9]
Iliocostalis thoracis (48.1*B*, p. 638)[9]
Multifidi (48.2*B*, p. 639)[9]
Quadratus lumborum (4.1*A*, p. 30)
Pyramidalis (49.2*D*, p. 664)[9]

BUTTOCK PAIN

Gluteus medius (8.1 TrP_1 and TrP_2, p. 151)
Quadratus lumborum (4.1*A* and 4.1*B*, p. 30)
Gluteus maximus (7.1*A*, *B*, and *C*, p. 133)
Iliocostalis lumborum (48.1*C*, p. 638)[9]
Longissimus thoracis (48.1*D*, p. 638)[9]
Semitendinosus and semimembranosus (16.1*A*, p. 317)
Piriformis (10.1, p. 188)
Gluteus minimus (9.1, p. 169 and 9.2, p. 169)
Rectus abdominis (49.2*A*, p. 664)[9]
Soleus (22.1 TrP_3, p. 429)

The Trigger Point Manual.
Simons, Travell and Simons, 1999

"Poking around at night on the muscles over my shoulder blade, trying to give some "do-it-yourself" massage, I was astonished to touch some spots that intensified, or reproduced my pain, as though I had turned on an electric switch. It was my first introduction to the enigmatic trigger area. No nerve existed, I knew, to connect those tiny spots directly with my arm. *I was baffled, but I did not discard the observation on the grounds that I could not explain it"*

Travell, J. *Office Hours: Day and Night* (1968)

THE MYOFASCIAL GENESIS OF PAIN

JANET TRAVELL AND SEYMOUR H. RINZLER*
Cornell University Medical College and Beth Israel Hospital, New York

Trigger Areas in Myofascial Structures Can Maintain Pain Cycles Indefinitely

THE TRIGGER AREA

Data are drawn from about 1000 patients with (1) pain syndromes and (2) myofascial trigger areas.

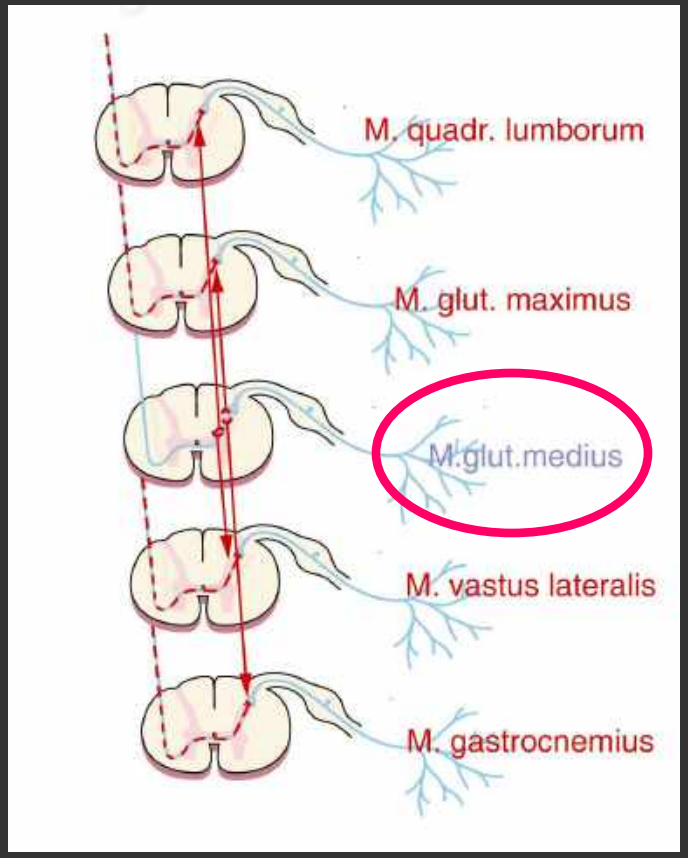
The trigger area is a small hypersensitive region from which impulses bombard the central nervous system and give rise to *referred*

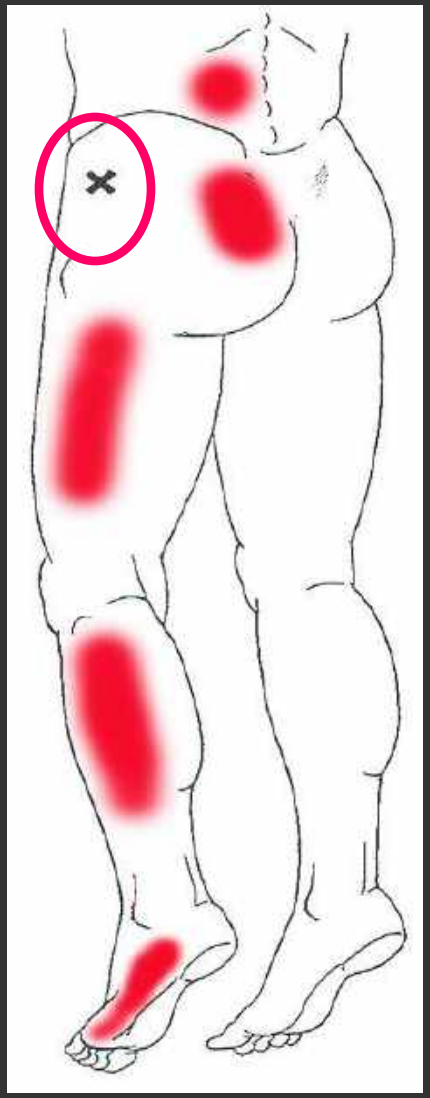
may be accompanied
other autonomic effect
zone of pain.

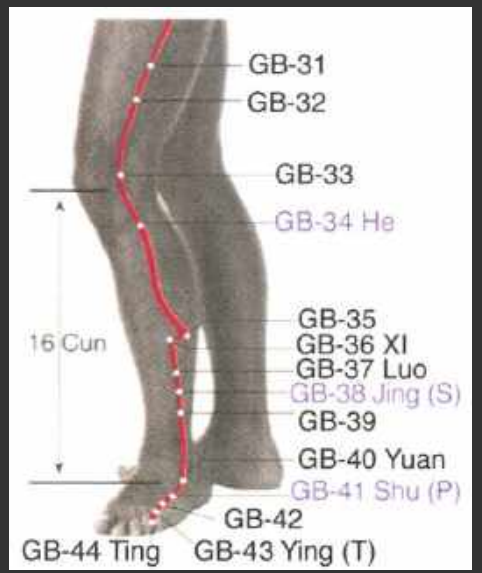
A trigger area at a
to a similar distributio
person as in another.

This constancy of p
pulses concerned in th

Opening of Previously Ineffective Synapses







Active trigger point at the gluteus minimus muscle

↓

Enlargement of receptive field by sensitization (mostly peripheral)

↓

Persistent nociceptive input to 2nd order neuron at the dorsal horn

↓

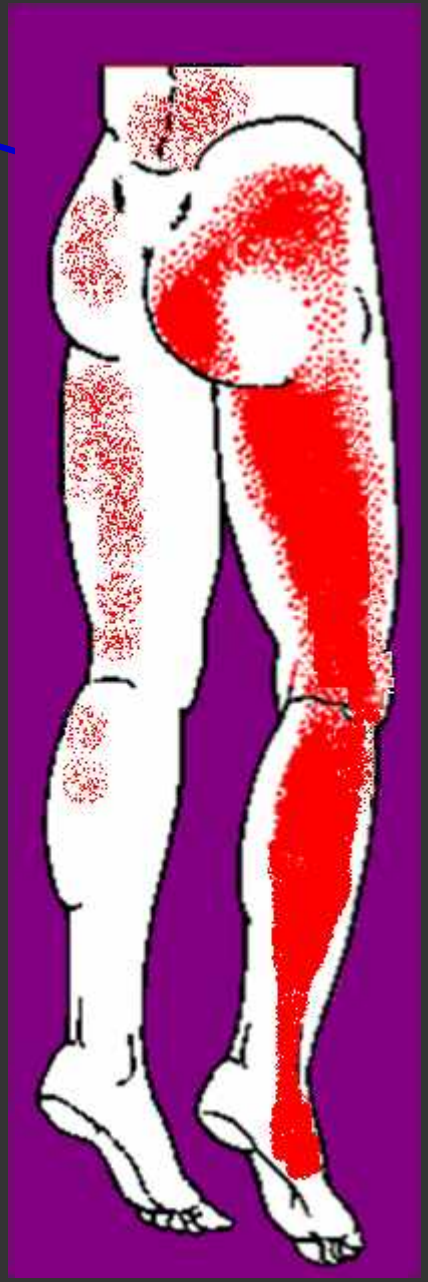
Central Sensitization
Spinal Segmental Sensitization

↓

Spontaneus pain at S1 spinal level
Dermatome, myotome, sclerotome manifestations

↓

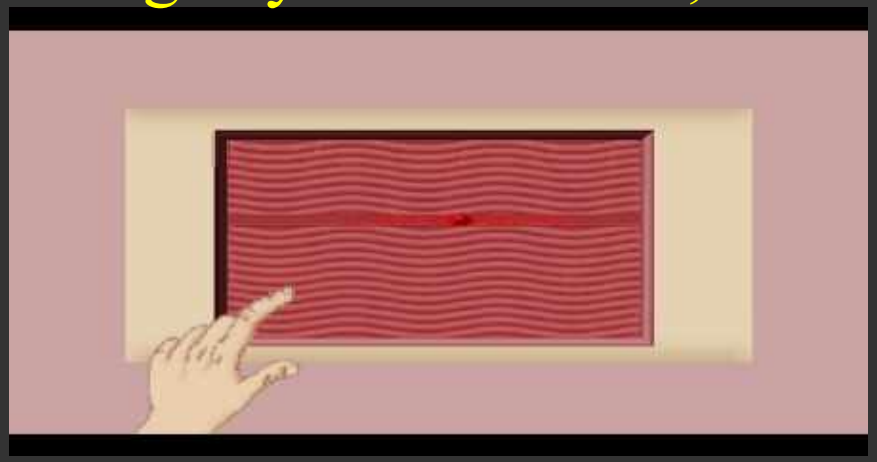
Spread of sensitization to other dorsal horn levels and to contralateral side



Controversies about MTrPs and Myofascial Pain

- What is the etiology and pathophysiology?
- What is the mechanism by which pain state begins, evolves and persists?
- How does a tender nodule progress to a myofascial pain syndrome?
- No consensus about which soft tissues are involved
- The physical findings are not always discernable
- No consensus about objective measures for therapeutic outcomes
- No consensus about physical findings except the MTrP

Although Digital Palpation of MTrPs is the Gold Standard for Diagnosing Myofascial Pain, it Does Not:



Hans-Werner Weisskircher
www.trigger-point.com

- Provide a reliable and sensitive method of diagnosis and measurement of treatment efficacy
- Provide quantitative comparisons of the tissue properties before and after treatment
- Permit objective study of the natural Hx of MTrPs
- Objectively discriminate between superficial and deep MTrPs or describe the surrounding milieu

Novel Applications of Ultrasound Technology to Visualize and Characterize Myofascial Trigger Points and Surrounding Tissue:

A New Direction to Address an Old Controversy

Controversy over Myofascial Pain and MTrPs

"Everyone has trigger points"

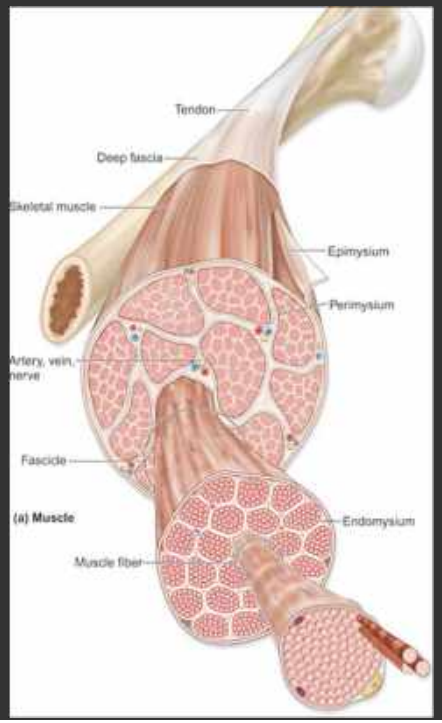
"That's your opinion. I can't find them"

"I don't *believe* they exist"

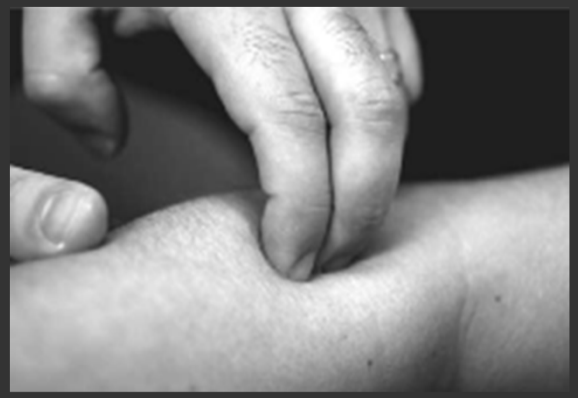
The Soft Tissue Neighborhood of Muscle & Fascia

Interrelationships between soft tissue structure, mechanical properties, and vascular physiology are implicated in myofascial pain

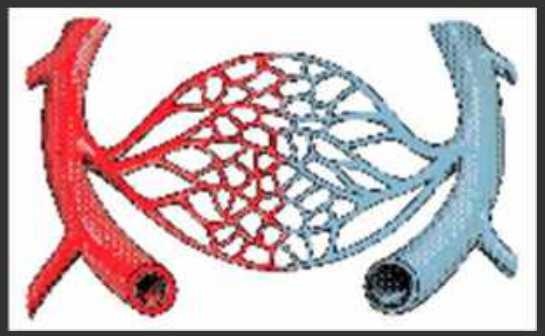
Microstructure and composition



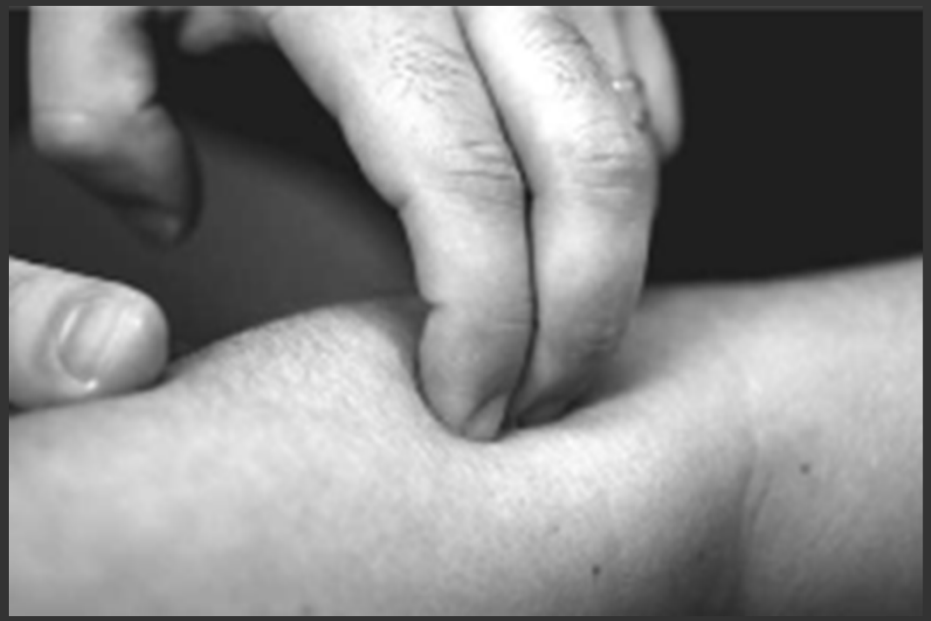
Mechanical (viscoelastic) tissue properties

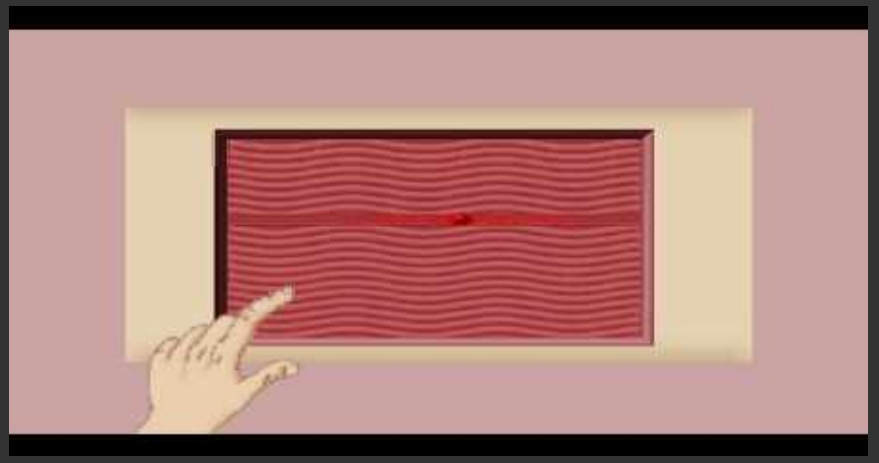


Vascular environment



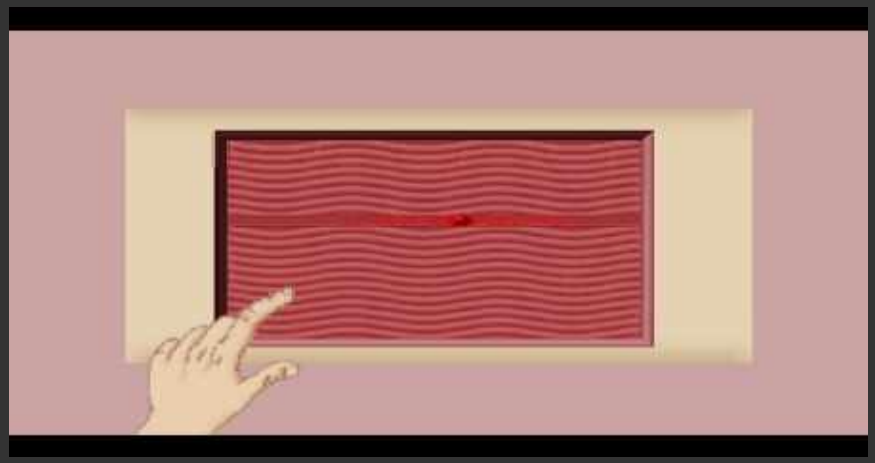
What happens when you palpate the soft tissue?





You are estimating the mechanical properties of the soft tissue in response to your perturbation/deformation

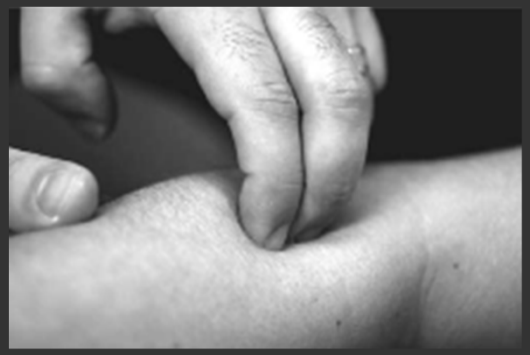
All soft tissue in the body can be classified as Viscoelastic - a term used when a medium exhibits properties of both fluids (viscous) and solids (elastic) while undergoing deformation.

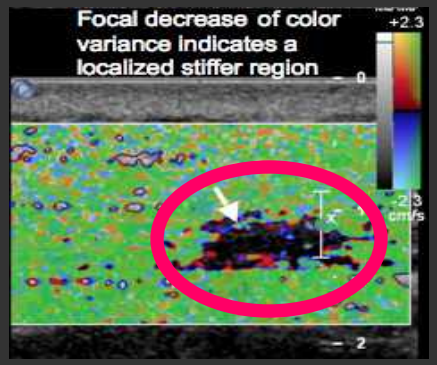


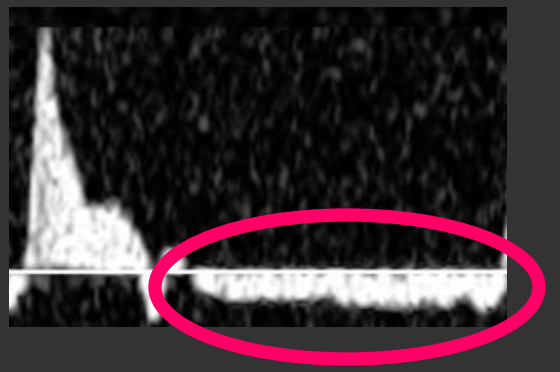
Hans-Werner Weisskircher
www.trigger-point.com

Lack of Consensus on the Diagnostic Criteria, including the Relationship between MTrP and MPS

- The lack of objective clinical outcome measures has been a barrier to critical evaluation of the efficacy of therapeutic methods like manual therapies, dry needling, acupuncture, etc.
- Ultrasound imaging can be used to visualize MTrPs and for objective clinical assessment in conjunction with digital palpation
- MTrPs are stiffer than surrounding tissue; *active* MTrPs have a larger surface area than latent MTrPs and *active* MTrPs can be distinguished from latent MTrPs by their unique blood flow waveform characteristics





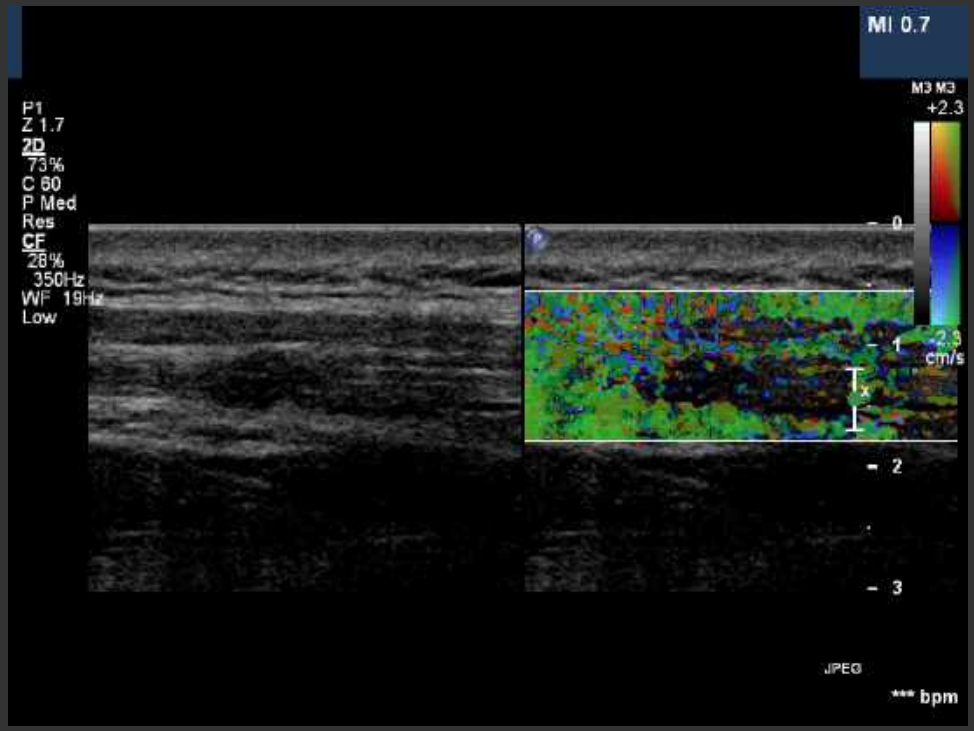


Sikdar et. al. *Archives of PM&R*. 2009
Ballyns et. al. *J Ultrasound Med* 2011

The MTrP is a Unique Physical Finding in MPS

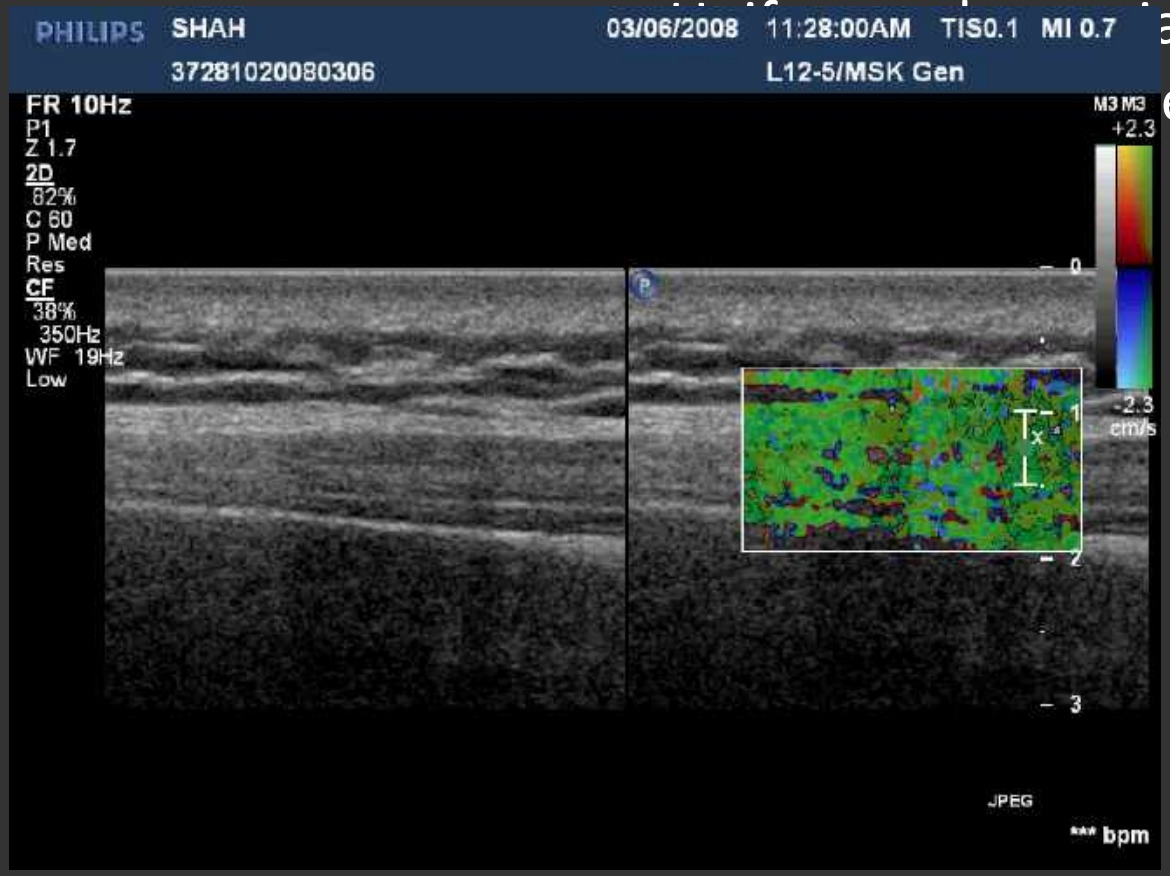
- We are able to "*exploit*" the physical properties of the MTrP and its adjacent milieu and describe it more objectively
- This provides a useful starting point to investigate the patho-physiology of MPS and its relationship to established mechanisms of muscle pain

Courtesy Bryan O'Neill

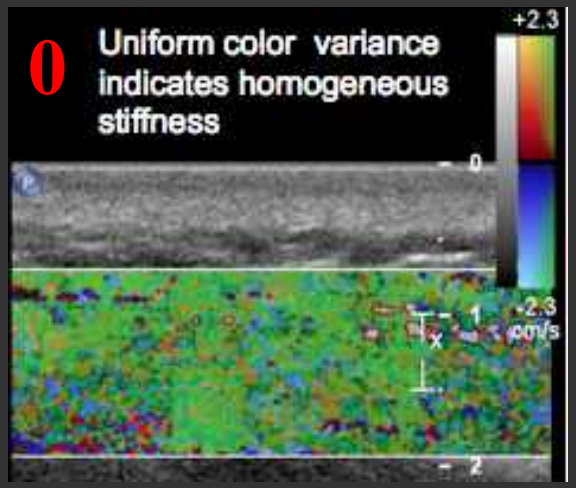


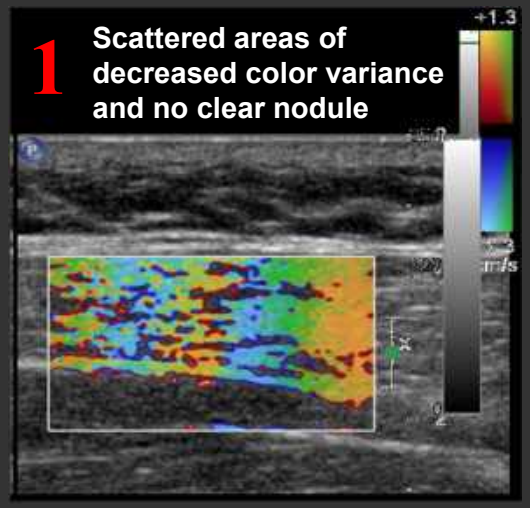
Sikdar et. al. *Archives of PM&R*. 2009

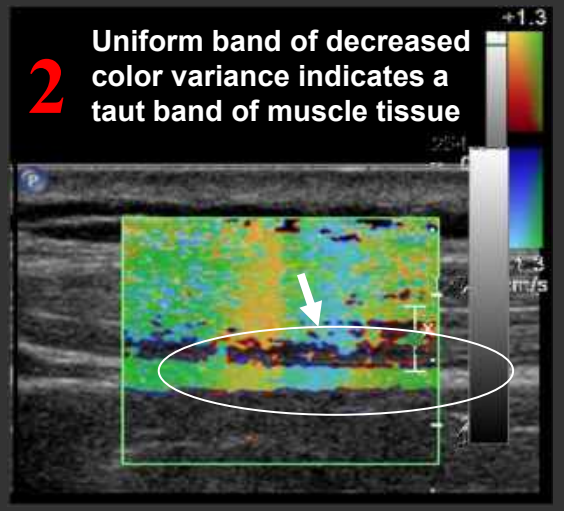
Vibration Sonoelastography of Uninvolved Muscle

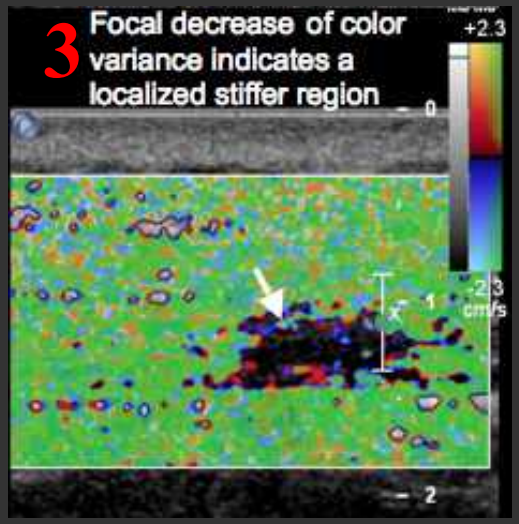


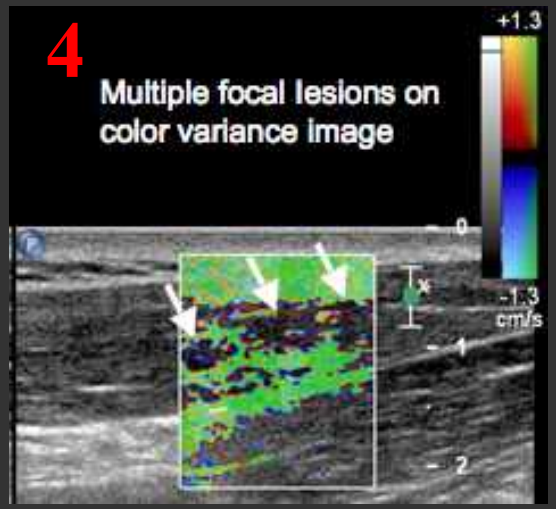
Spectrum of Sonoelastography Images









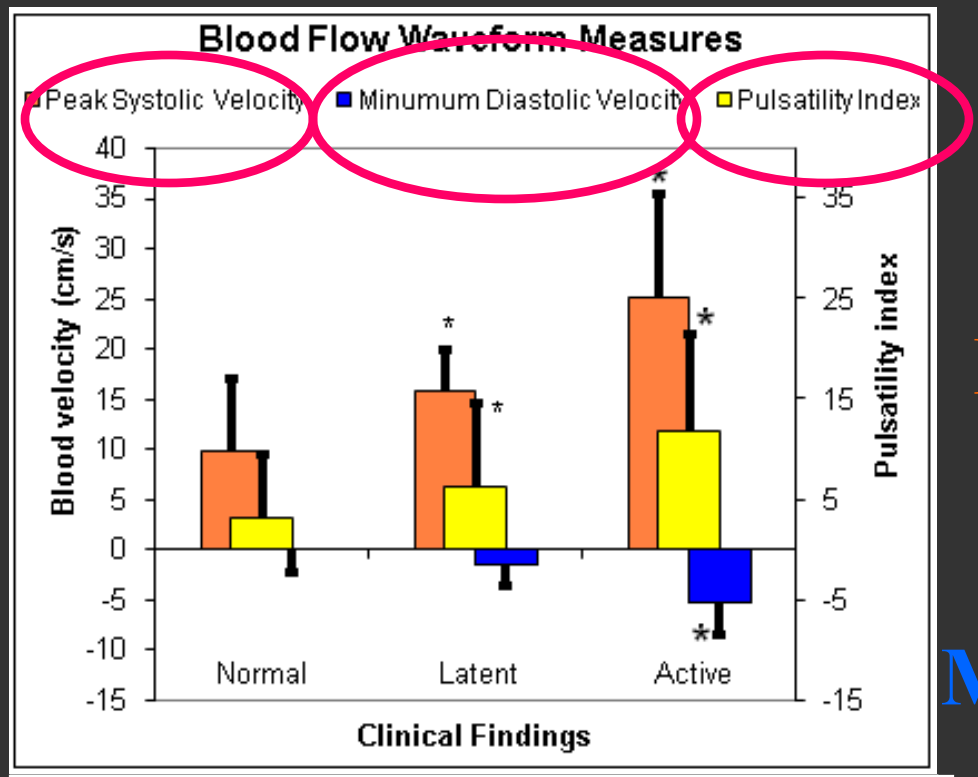


Sikdar et al. *IEEE Ultrasonics Sym.*, 2010

Imaging Advantages:

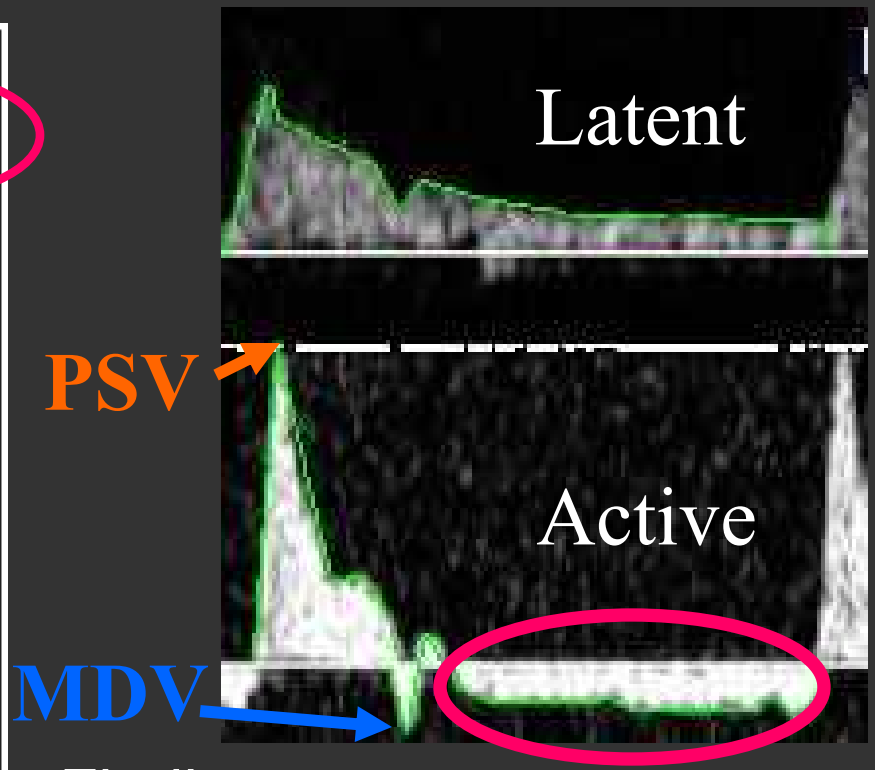
1) Objective Dx test – Quantify size and # of MTrPs
2) Objective description of natural history of MFP
3) Identify MTrPs in deeper tissue beyond palpation
4) Objective outcome measure to evaluate tissue changes in response to treatment

Quantitative Blood Flow Measures



	Peak Systolic Velocity	Minimum Diastolic Velocity	Pulsatility Index
Normal vs. Latent	p=0.18	p=0.667	p=0.147
Normal vs. Active	p=0.006*	p=0.04*	p=0.03*
Latent vs. Active	p=0.04*	p=0.043*	p=0.32

*p<0.05 for a two-sided Mann-Whitney U-test



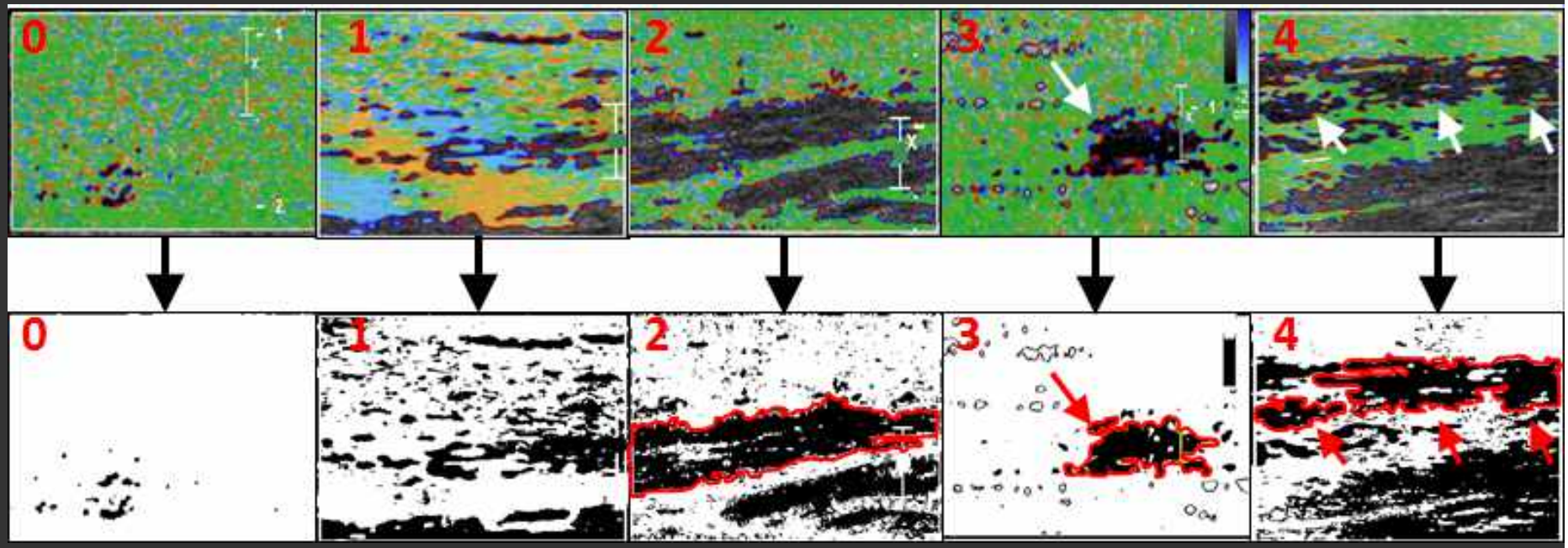
Findings:

1) *Active* MTrPs had more pulsatile flow with higher systolic and negative diastolic flow velocities

2) Compared to latent sites, A***ctive*** MTrPs display an increase in downstream vascular resistance and a more highly compliant local vascular environment

Sikdar et al. *IEEE EMBC.*, 2010

Trigger Point Area Measured by Importing Elastographic Images into Image J



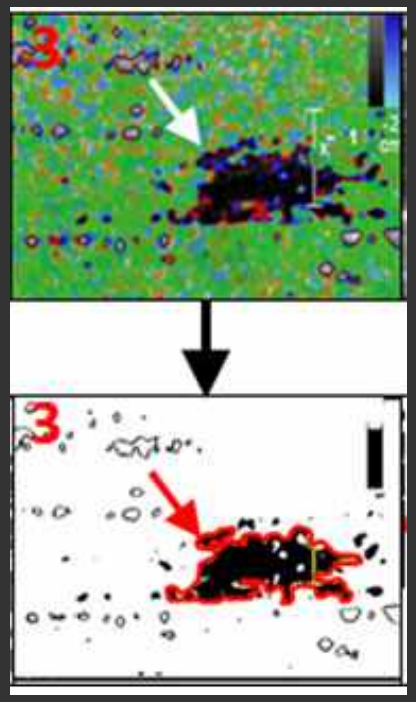
Ballyns et al., *J Ultrasound Med,* 2011

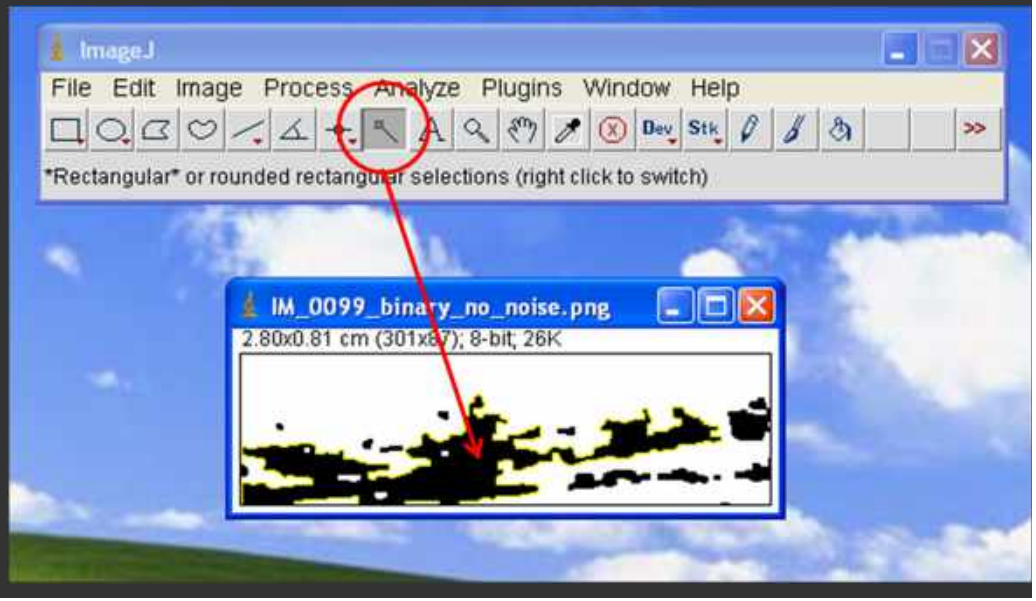
Measuring Trigger Point Surface Area

1) **Make the US image binary (black and white)**

2) **The tracing tool selects the black area that is evident in the color variance**

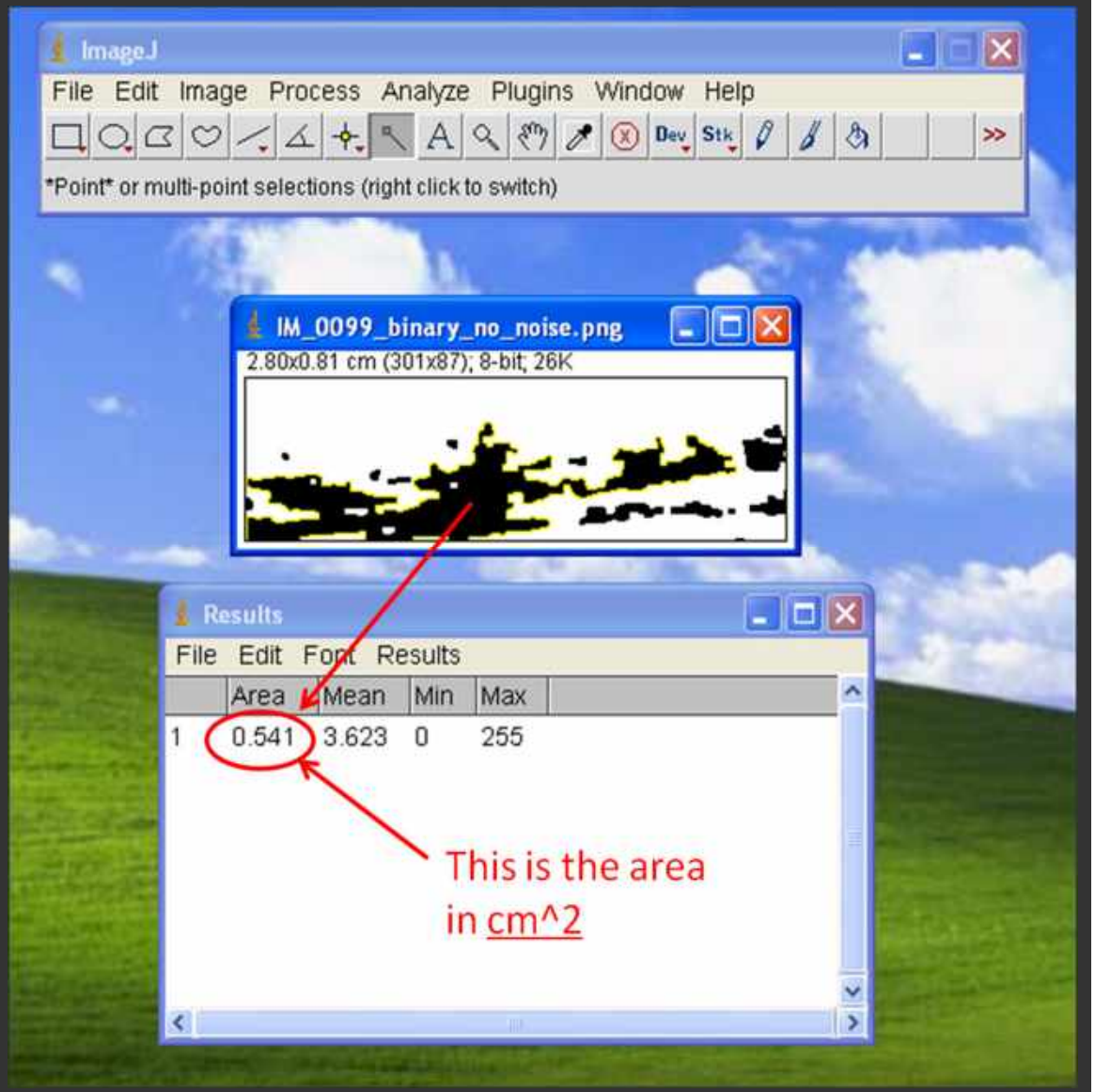
3) **The program recognizes the contiguous border and is able to select it as an individual entity**





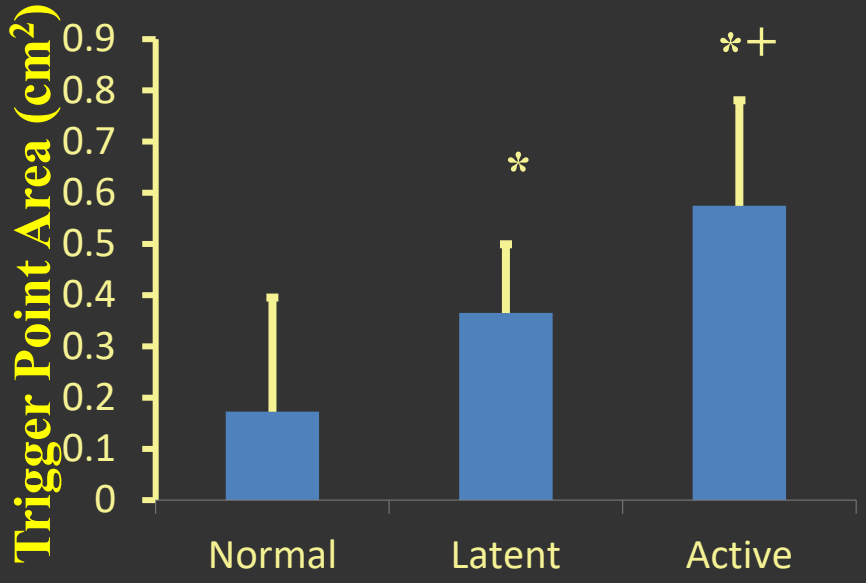
Measuring Trigger Point Surface Area

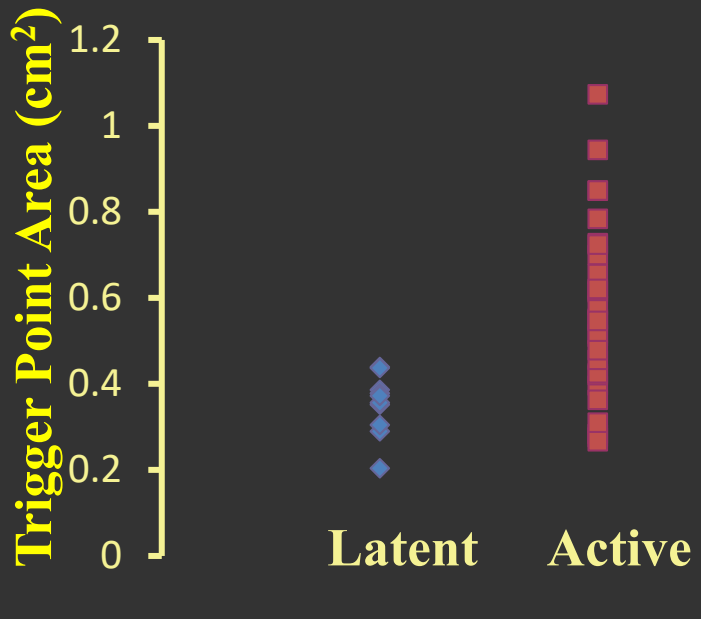
4) **Program is able to count each individual pixel to calculate a measurement of surface area**



Trigger Point Area

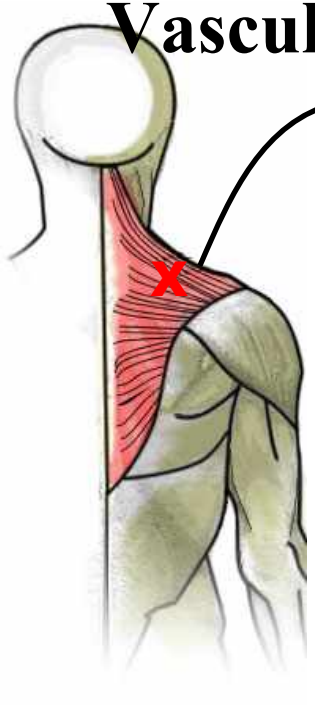
N=44 subjects with cervical pain
169 muscle sites

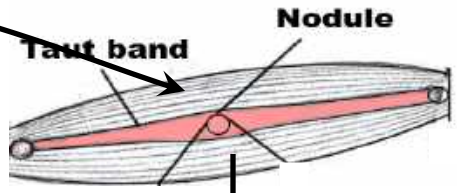


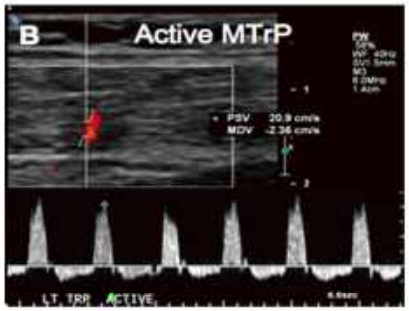


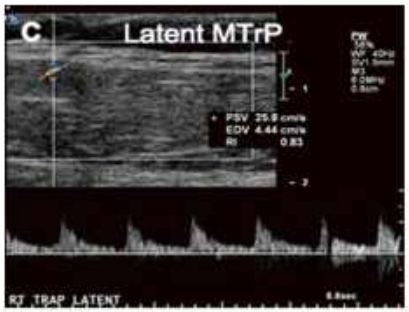
Ballyns et al., *J Ultrasound Med,* 2011

Vascular Remodeling in the Neighborhood of the MTrP



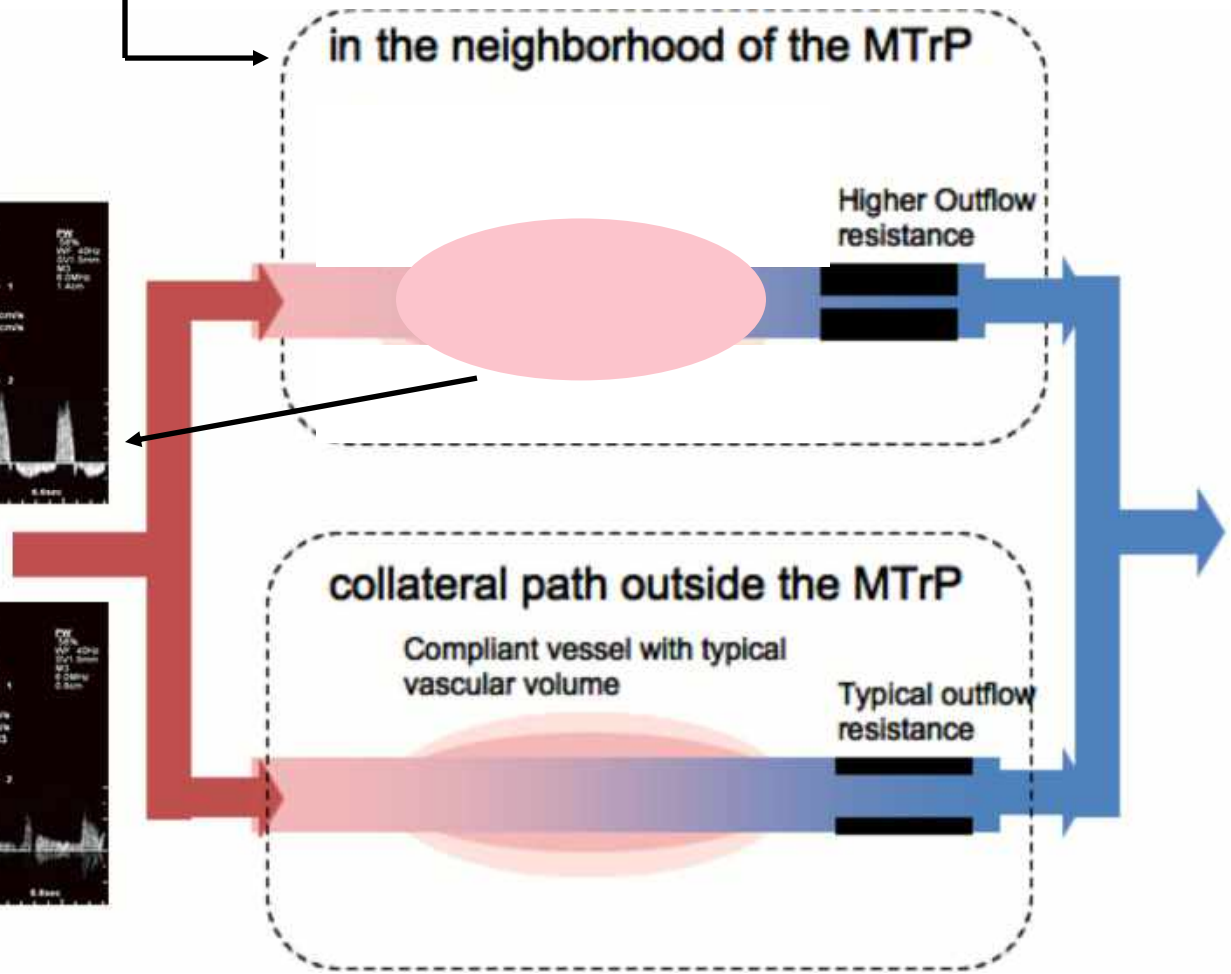






Reversal

No Reversal



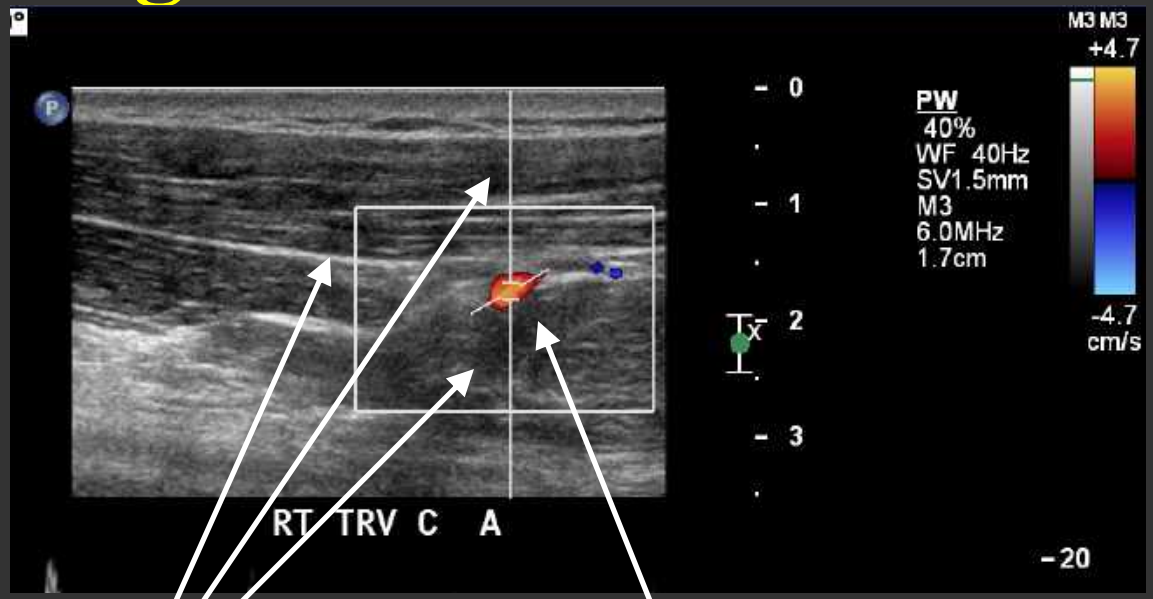
Vascular Remodeling: In the Neighborhood of the MTrP

Mechanisms of Vascular Remodeling

1. Vascular Redesign
2. Development of New Blood Vessels

   "Neo-vascularization"

Vascular Remodeling: In the Neighborhood of the MTrP

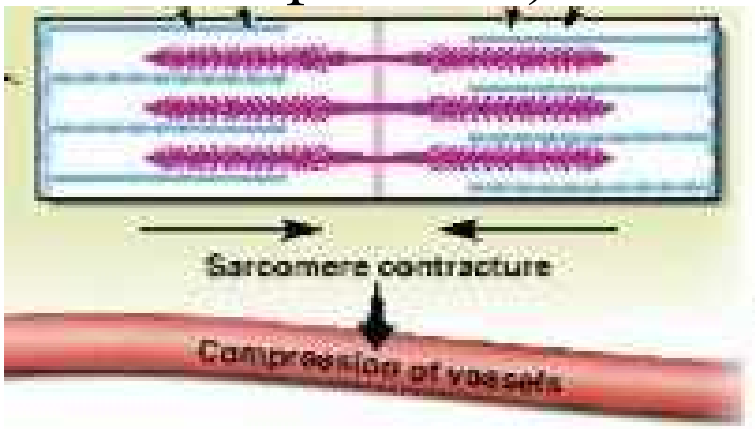


Hypoechoic Regions

Large Blood Vessel

Observations

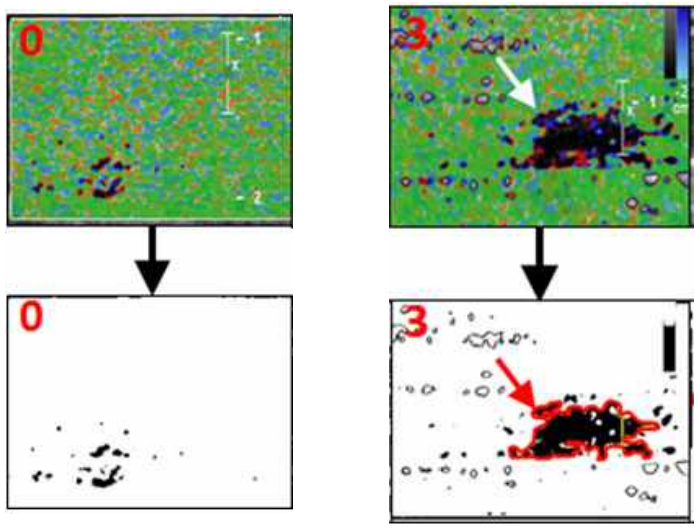
- MTrPs exhibit different echogenecity compared to surrounding muscle
- Vibration sonoelastography shows differences in relative stiffness between MTrPs and normal (uninvolved) muscle
- Blood flow waveform characteristics can be used to differentiate ***Active*** and Latent MTrPs
- Retrograde flow in diastole (indicating a very high resistance vascular bed and possible blood vessel compression) is associated with ***Active*** MTrPs



Sikdar S, Shah JP, Gebreab T, Yen R, Gilliams E, Danoff J, Gerber L. Applications of Ultrasound Technology to Visualize and Characterize Myofascial Trigger Point and Surrounding Soft Tissue. *Arch. Phys. Med. Rehabil.,* 2009

Observations

- Vibration sonoelastography is an effective method for measuring MTrP size and was excellent for distinguishing the site type
- Sonographic techniques can play a role in:
  - Objectively identifying active vs. latent MTrPs
  - Developing outcome measures after therapeutic intervention
  - Better describing the complex environment surrounding MTrPs



Ballyns et al., *J Ultrasound Med,* 2011

3 Week Dry Needling Treatment for Chronic Cervical MPS

- The goal of this study was to assess the effect of a commonly used intervention (dry needling) to elicit a change in MTrP status
- The primary outcomes, change in level of pain and status of the MTrP were used to power the study
- Currently, assessments of patients with MPS rely upon self-reports that use descriptors of the pain, its frequency and its intensity
- These measures are valid; however, their sensitivity to change and the variation of interpretation by individual patients makes quantification difficult
- We conducted a prospective, interventional clinical study to determine whether a 3-week course of once/week dry needling of an active MTrP alters patient report of pain and concomitantly alters the status of the MTrP

3 Week Dry Needling Treatment for Chronic Cervical MPS

- A significant number of subjects experienced a change in MTrP status from active to latent or active to resolved (i.e., no palpable nodule)
- After Tx, the size of the A-MTrP decreased along with reduction in pain
- MTrPs that do not respond to treatment remain large and people with A-MTrPs unresponsive to Tx experience greater pain than responders
- DN changes the MTrP status and decreases MTrP size
- DN decreases VAS and BPI and increases PPT and cervical ROM
- DN improves SF-36 quality of life scores for pain, mental health and physical function

Gerber et. al. *PMR*. 2015

Dry Needling Decreases Pain of Chronic Cervical MPS and Improves Patient Outcomes through 6 weeks after Treatment

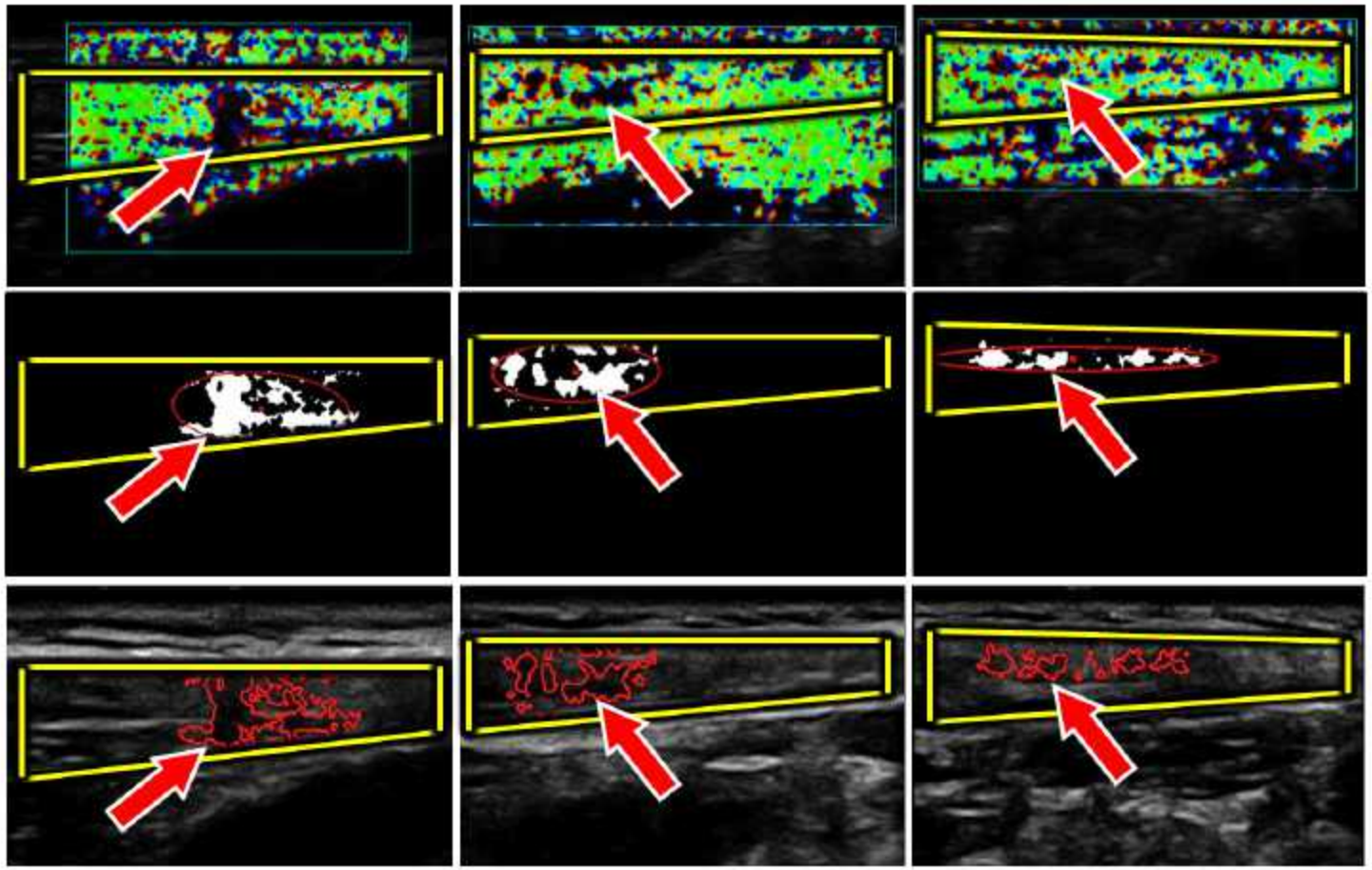
Significant improvements were found at 6 weeks after Tx compared to baseline in:

- Pain (Visual Analog Scale and Brief Pain Inventory)
- Disability (Oswestry Disability Scale)
- Cervical Range of Motion side-bending (unilateral)
- PPT (unilateral)
- SF-36 pain and physical function scores

Gerber et. al. *PMR*. 2016

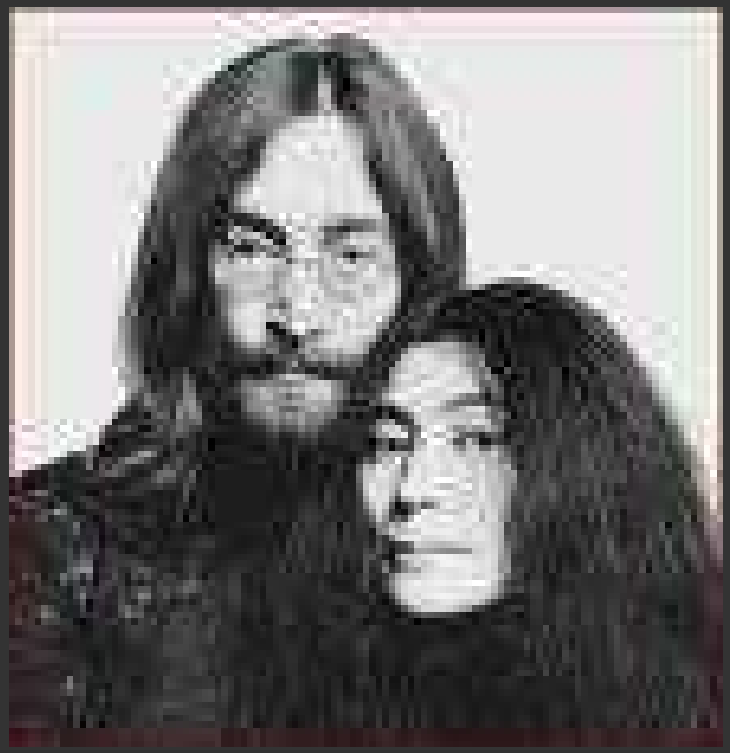
Ultrasound elastography can be used to quantify muscle tissue changes after dry needling treatment

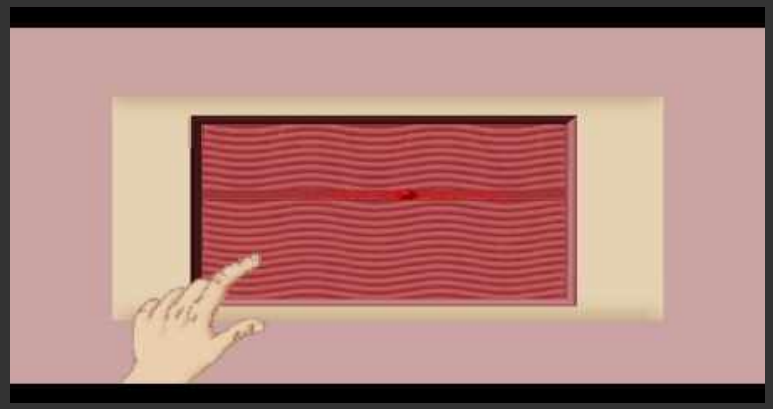
Figure 3



Turo et. al. *J Ultrasound in Medicine*. 2015

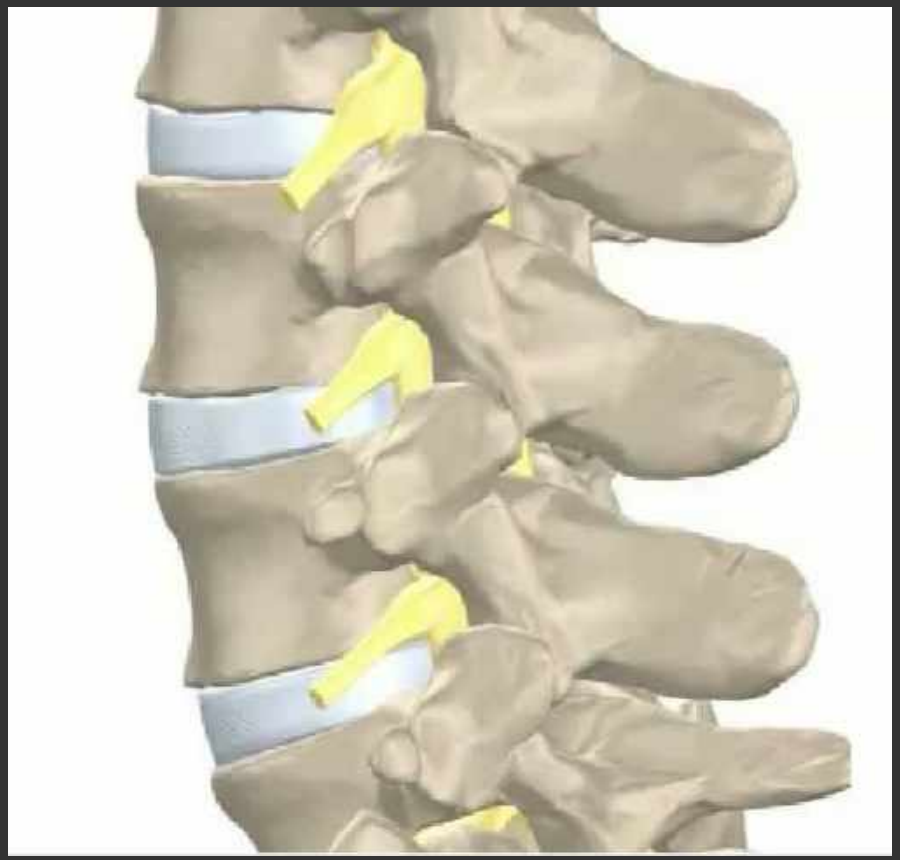
What do MTrPs and Yoko Ono have in Common?

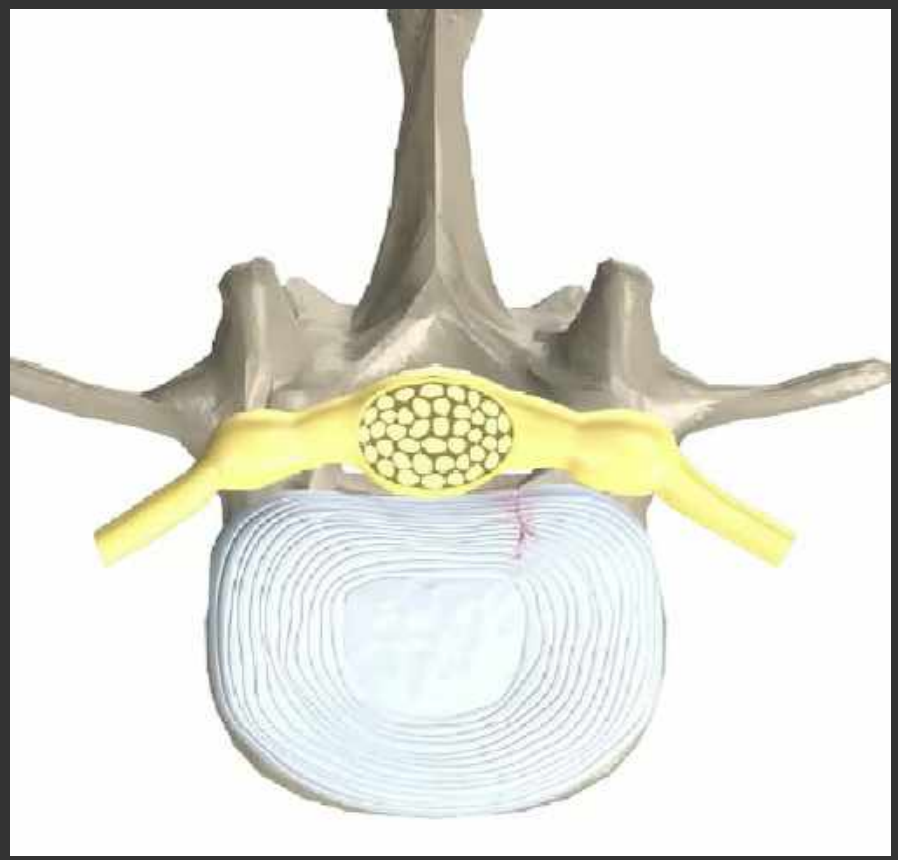




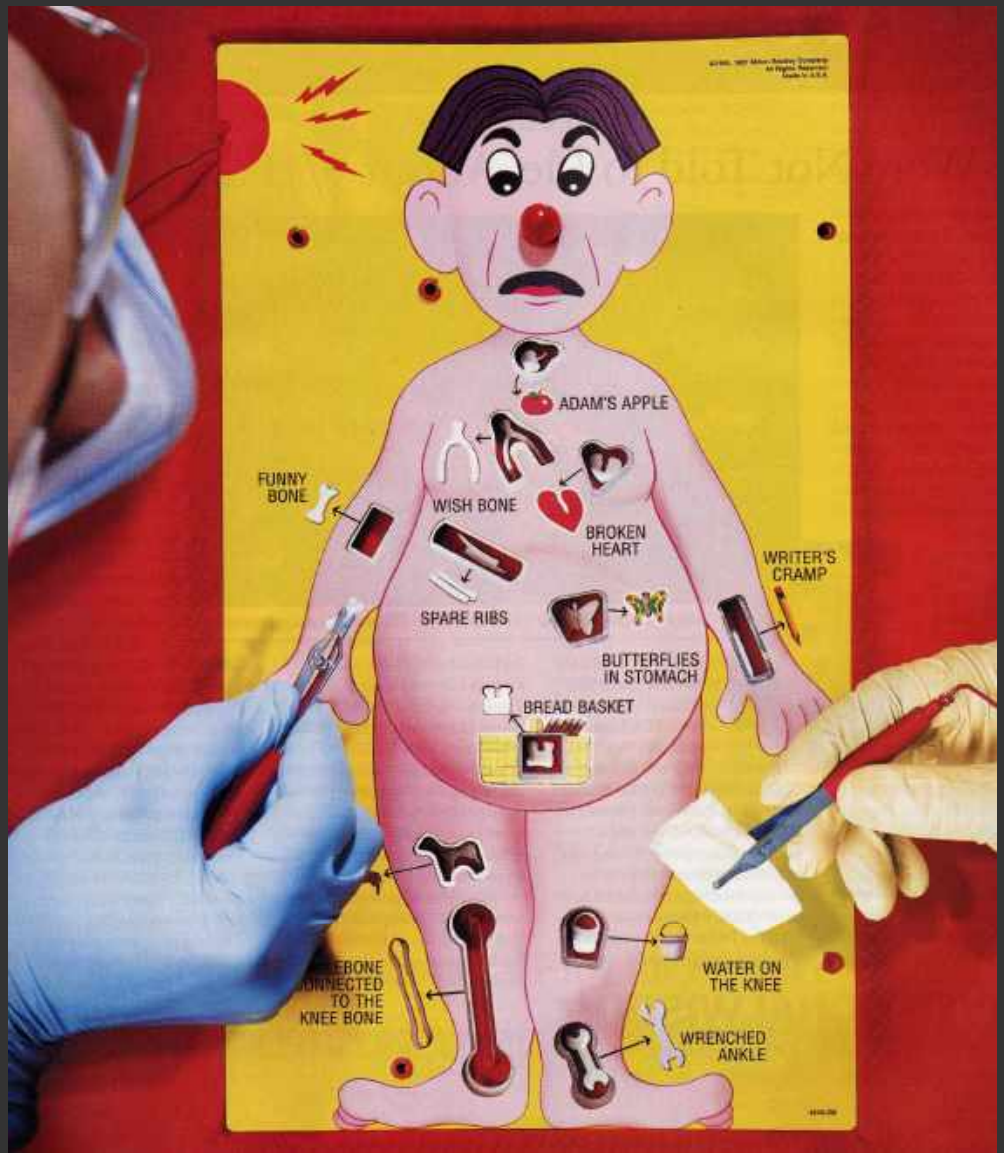
Spinal Segmental Sensitization and Facilitation:

An Alternative Explanation for Low Back Pain and Paraspinal Muscle Spasms Beyond the Medical Model of Pain

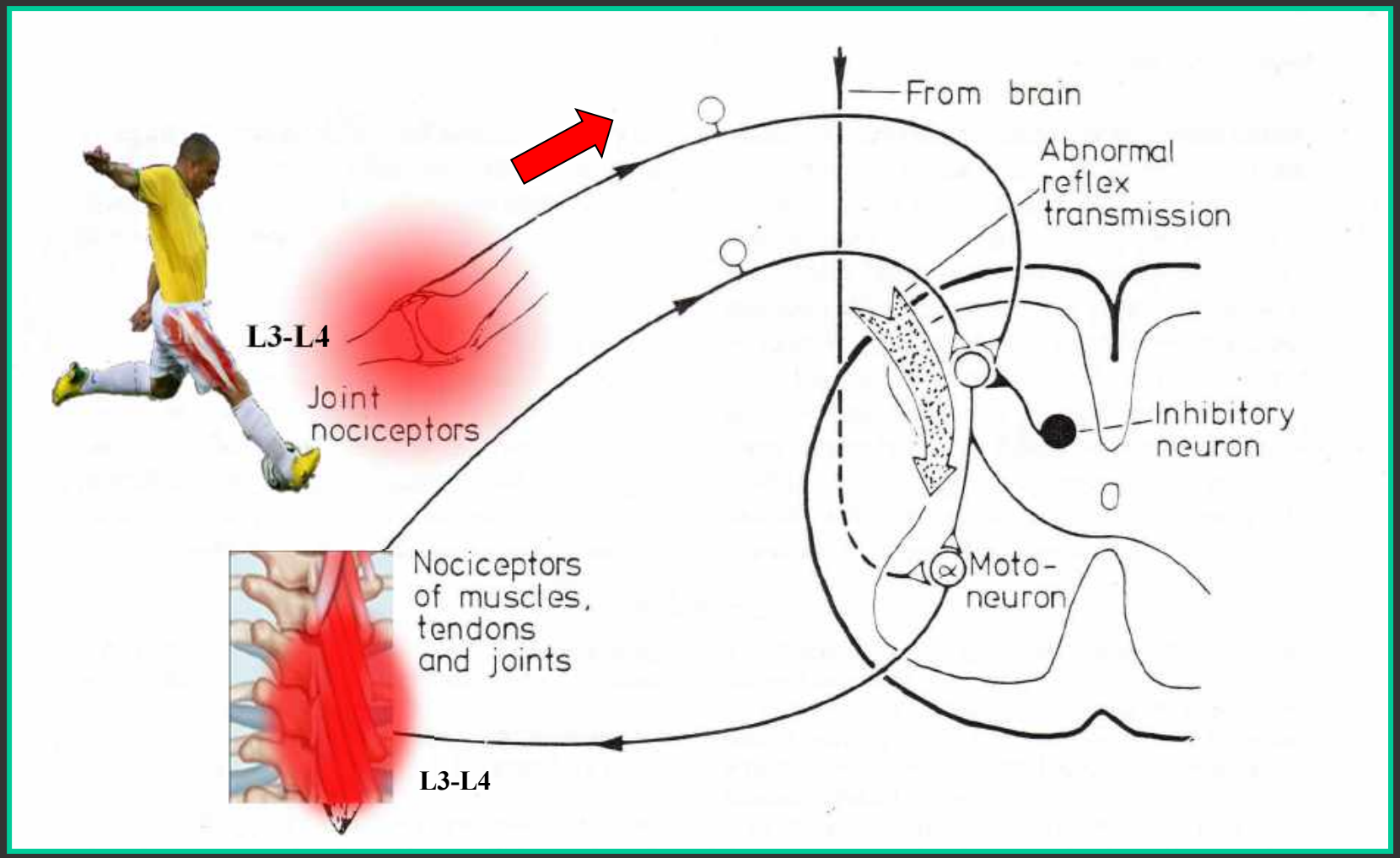




Beyond the Medical Model of Chronic Pain…

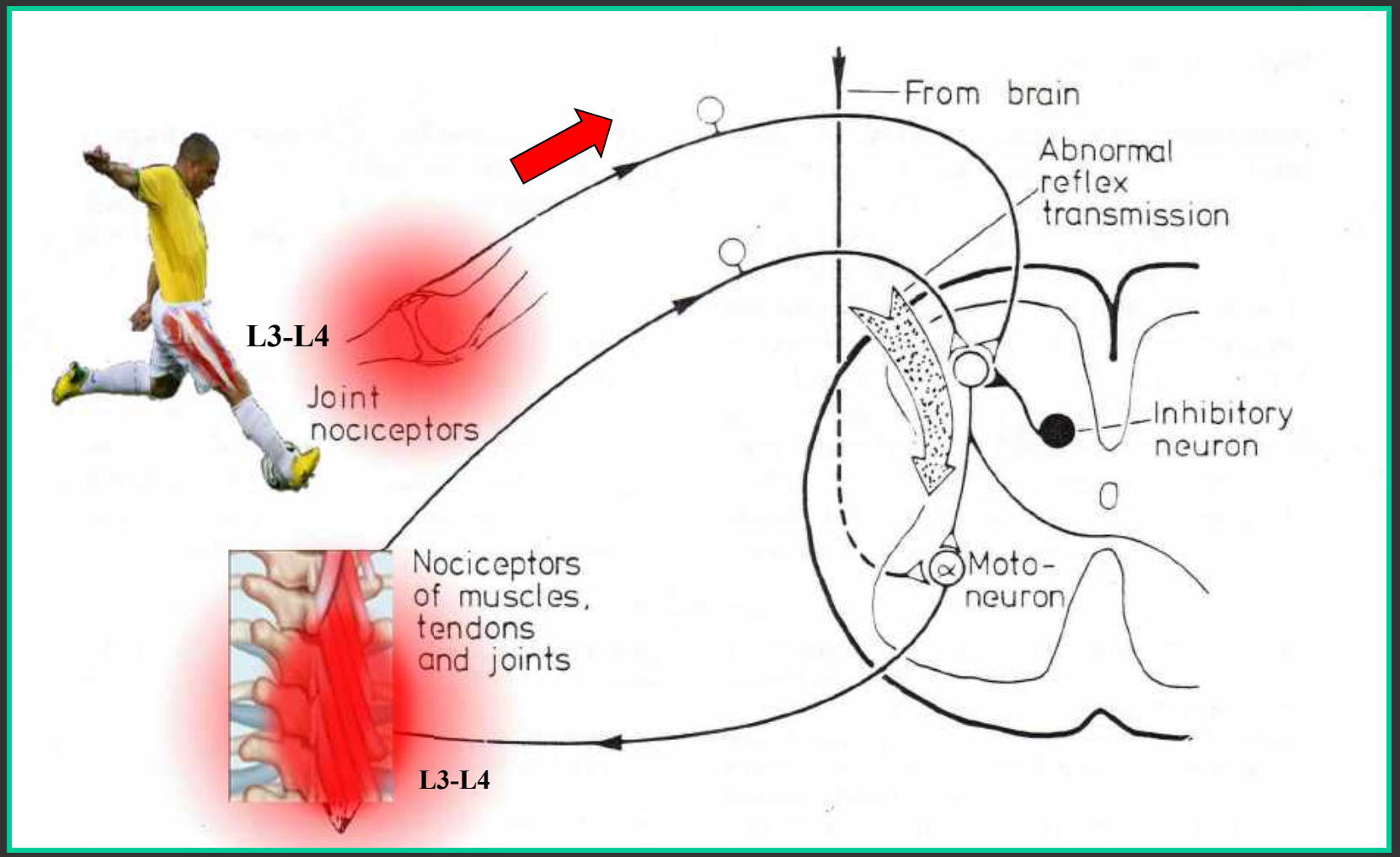


Spinal Facilitation - Application



Zimmermann, M. Pain mechanisms and mediators in osteoarthritis Sem Arth. Rheu. 18:22, 1989 Courtesy Frank Willard

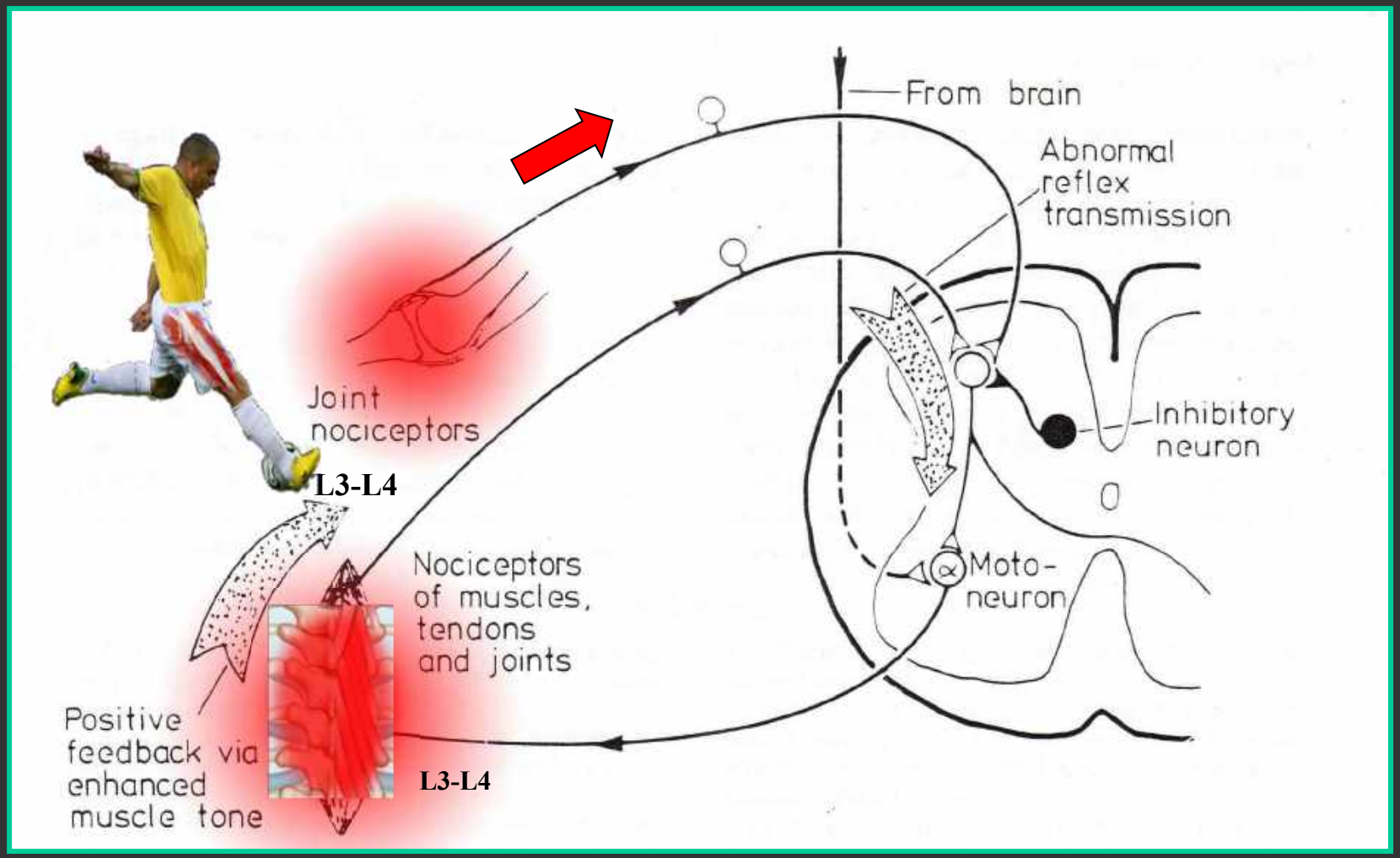
Spinal Facilitation - Application



Zimmermann, Sem Arth. Rheu. 18:22, 1989

Courtesy Frank Willard

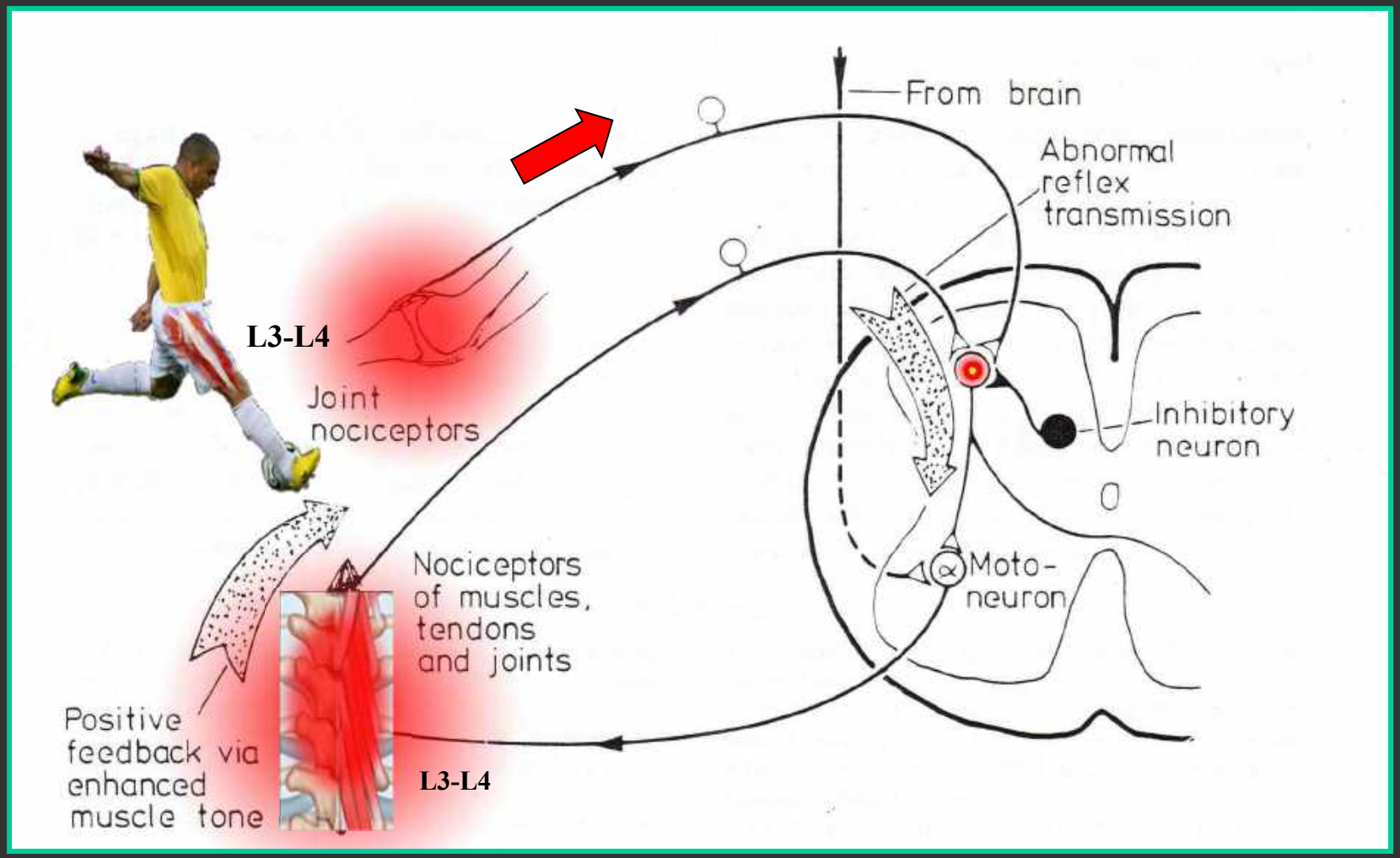
Spinal Facilitation - Application



Zimmermann, Sem Arth. Rheu. 18:22, 1989

Courtesy Frank Willard

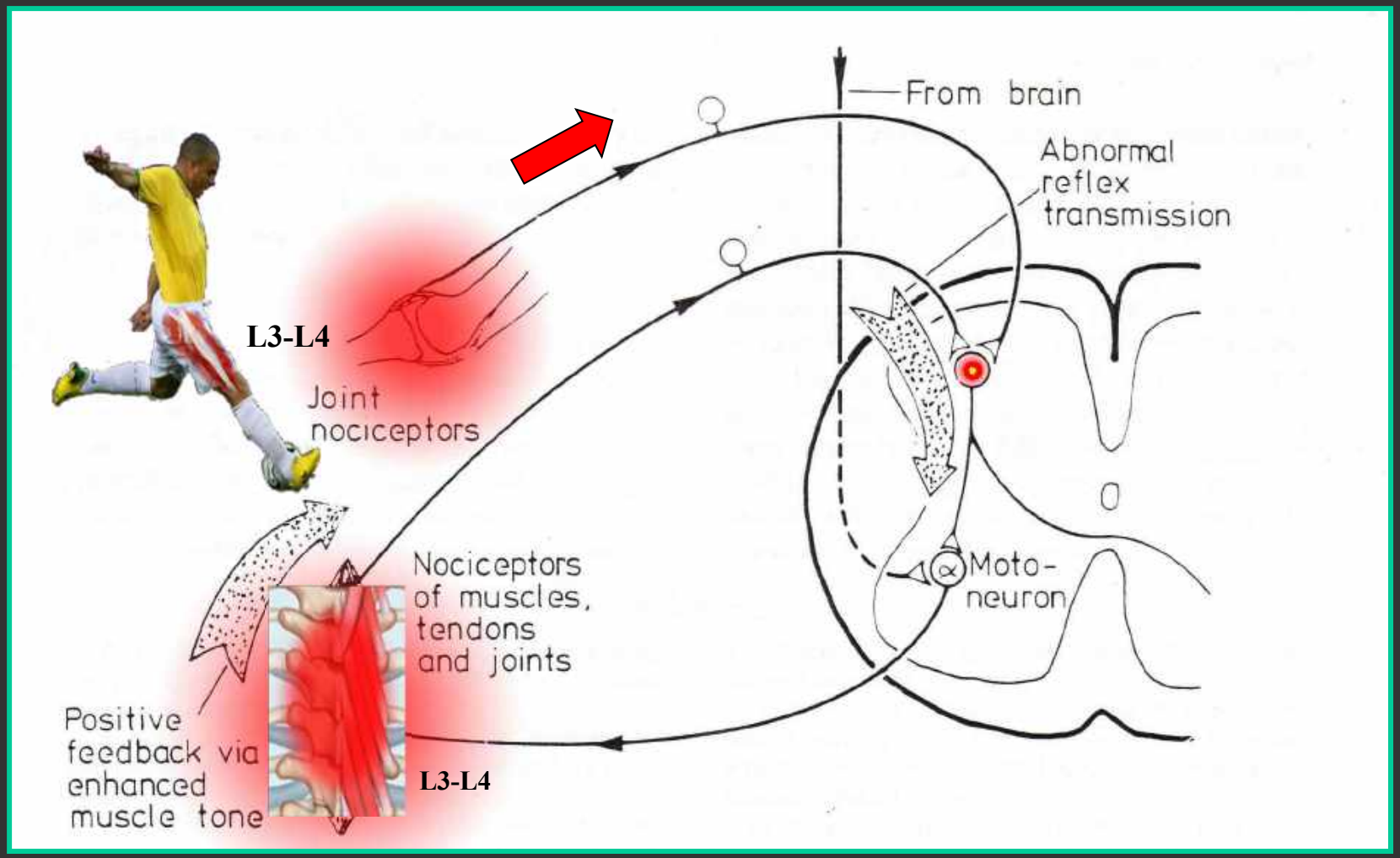
Spinal Facilitation - Application



Zimmermann, Sem Arth. Rheu. 18:22, 1989

Courtesy Frank Willard

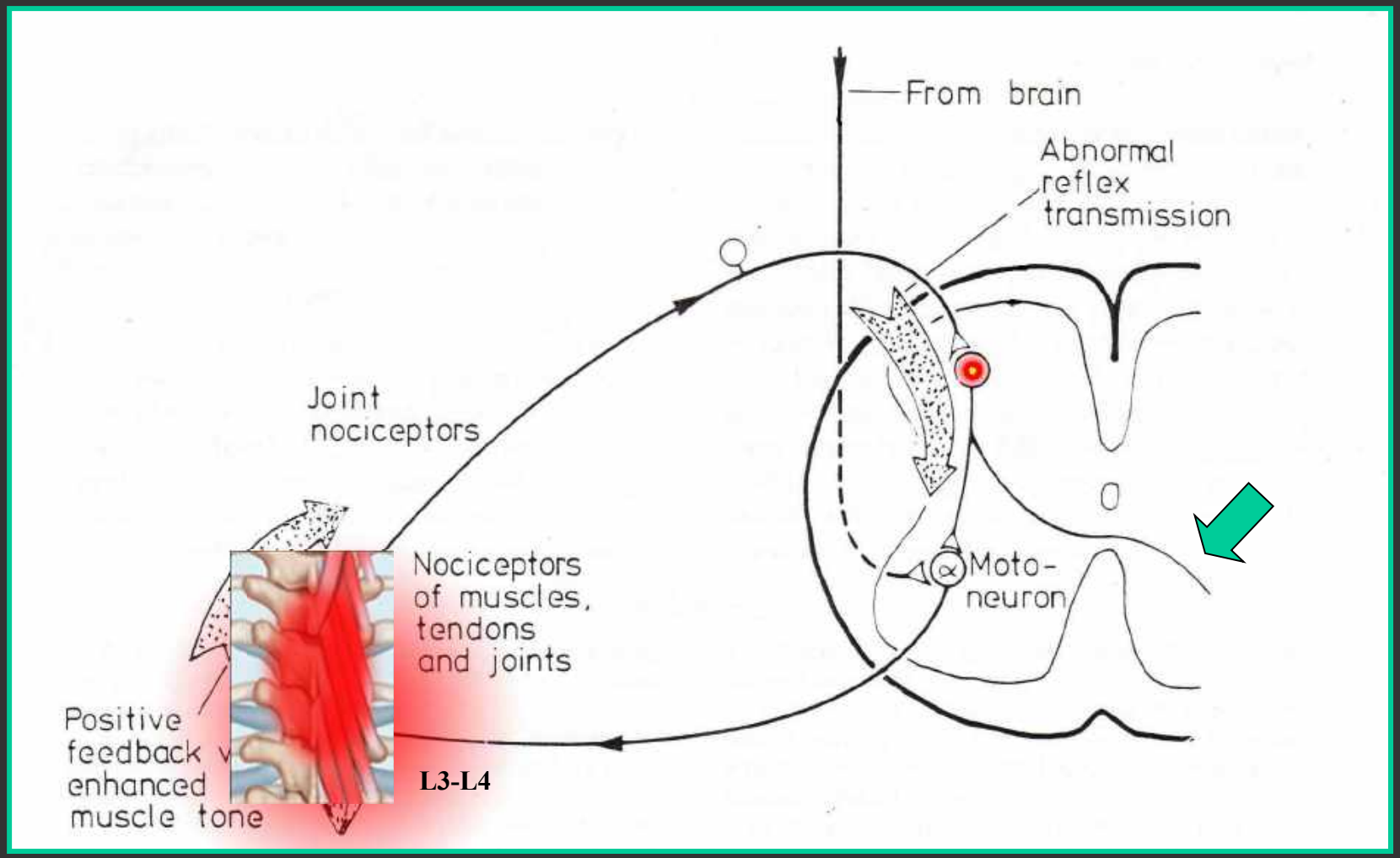
Spinal Facilitation - Application



Zimmermann, Sem Arth. Rheu. 18:22, 1989

Courtesy Frank Willard

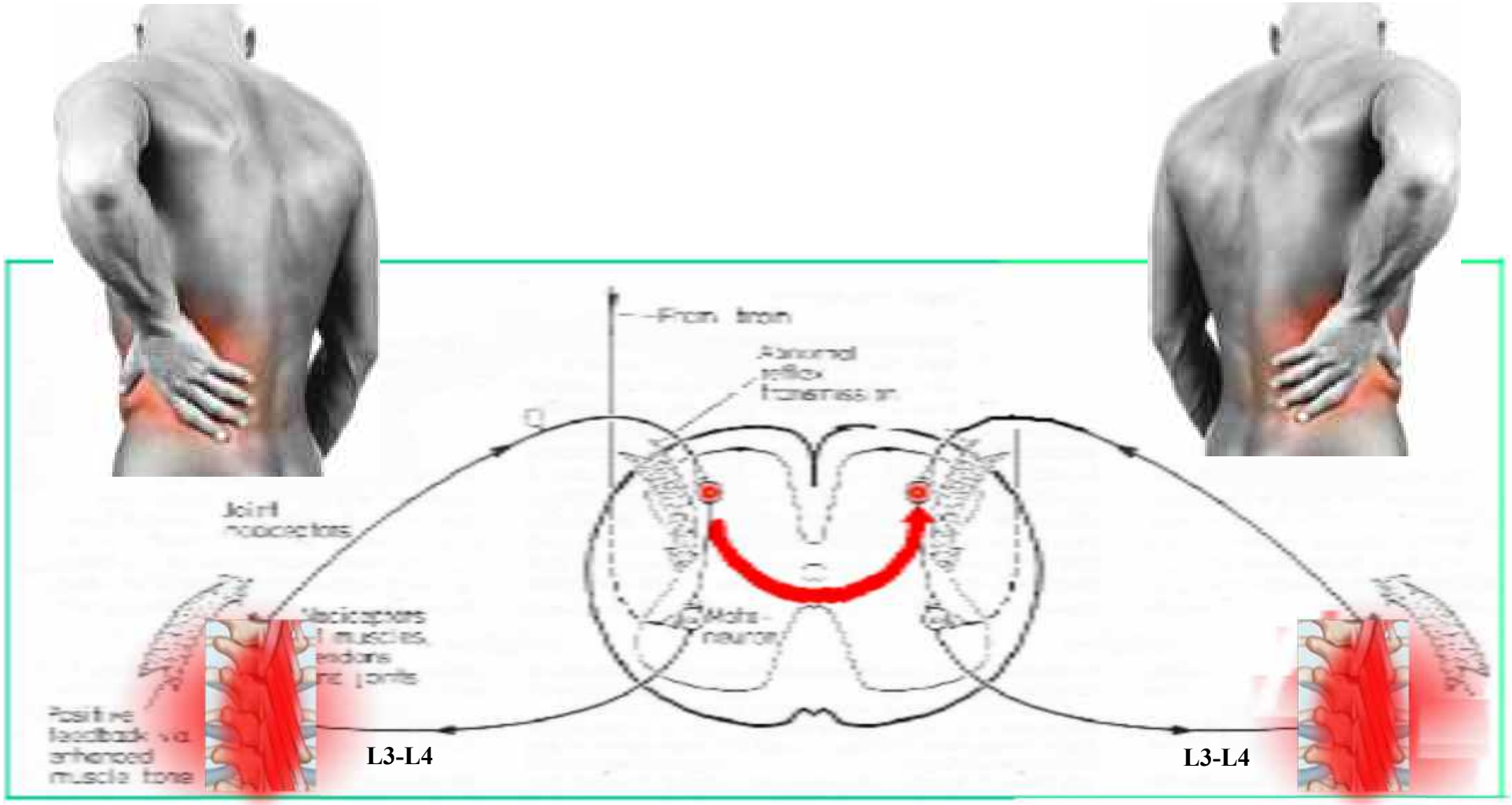
Spinal Facilitation - Application



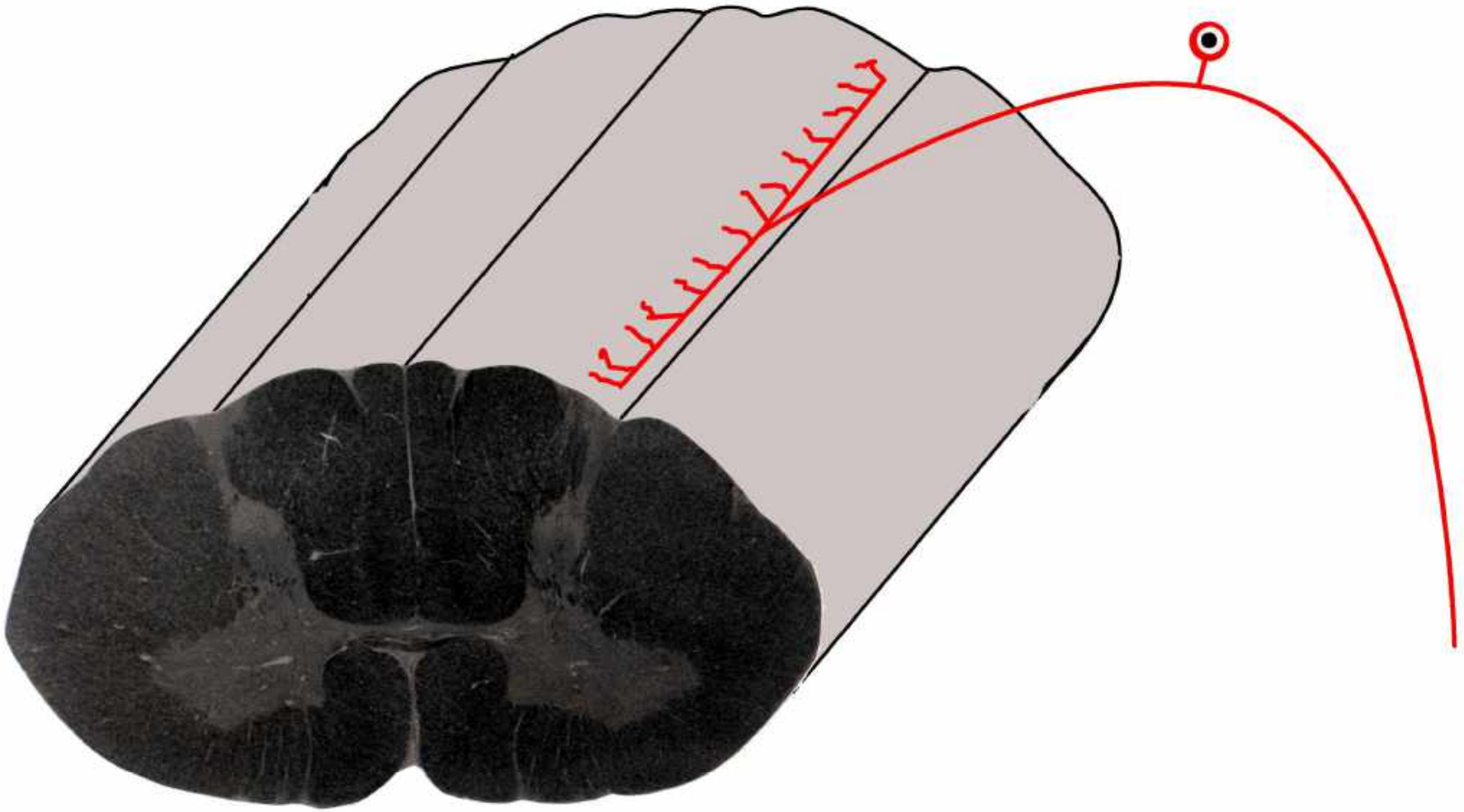
Zimmermann, Sem Arth. Rheu. 18:22, 1989

Courtesy Frank Willard

Pain Spreads to Contralateral Side



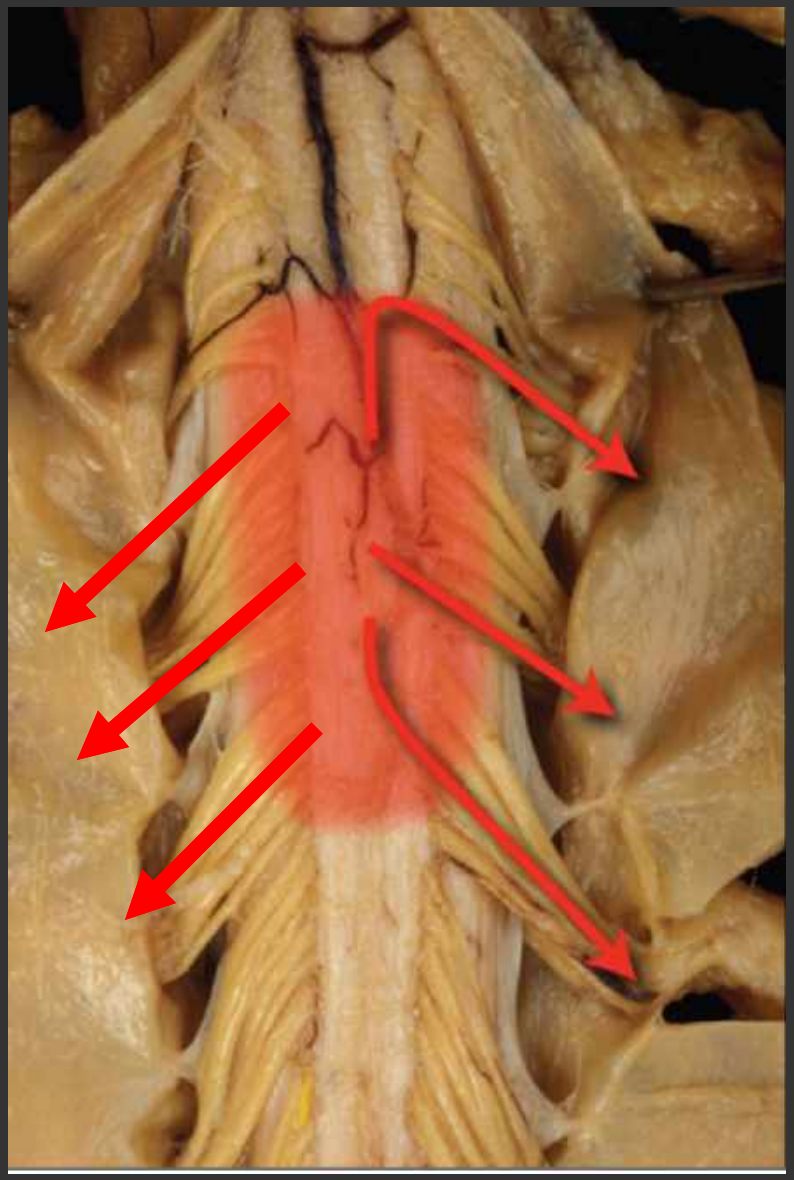
Zimmermann, Sem Arth. Rheu. 18:22, 1989



Spinal Facilitation - *Mechanisms*

- The nociceptors can be *sensitized*
- They, in turn, can *sensitize* the dorsal horn neuron, which can do permanent damage, creating an *uninhibited* segment
- That segment can be invaded from distant sites above and below the original segmental level of input

Dorsal Root Reflexes and mirror-image pain



Courtesy Frank Willard

Segmental Sensitization, Spinal Facilitation and Mirror-Image Pain

Question

Peripheral Sensitization is exacerbated by all of the following mechanisms except

A. Lowered pH in the periphery

B. Elevated bradykinin in the periphery

C. Lowered substance P levels in the periphery

D. Elevated serotonin in the periphery

Are Myofascial Trigger Points a Primary Problem or a Secondary Consequence?

Somatic Dysfunction

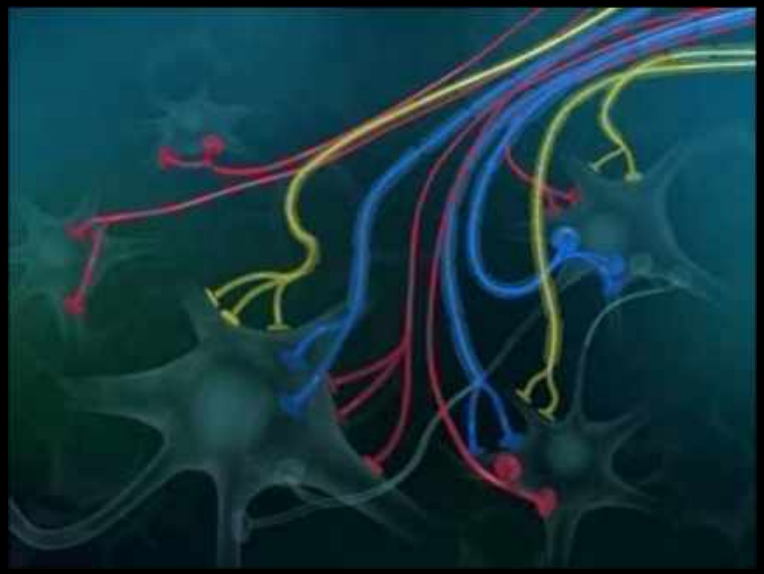
Visceral Dysfunction

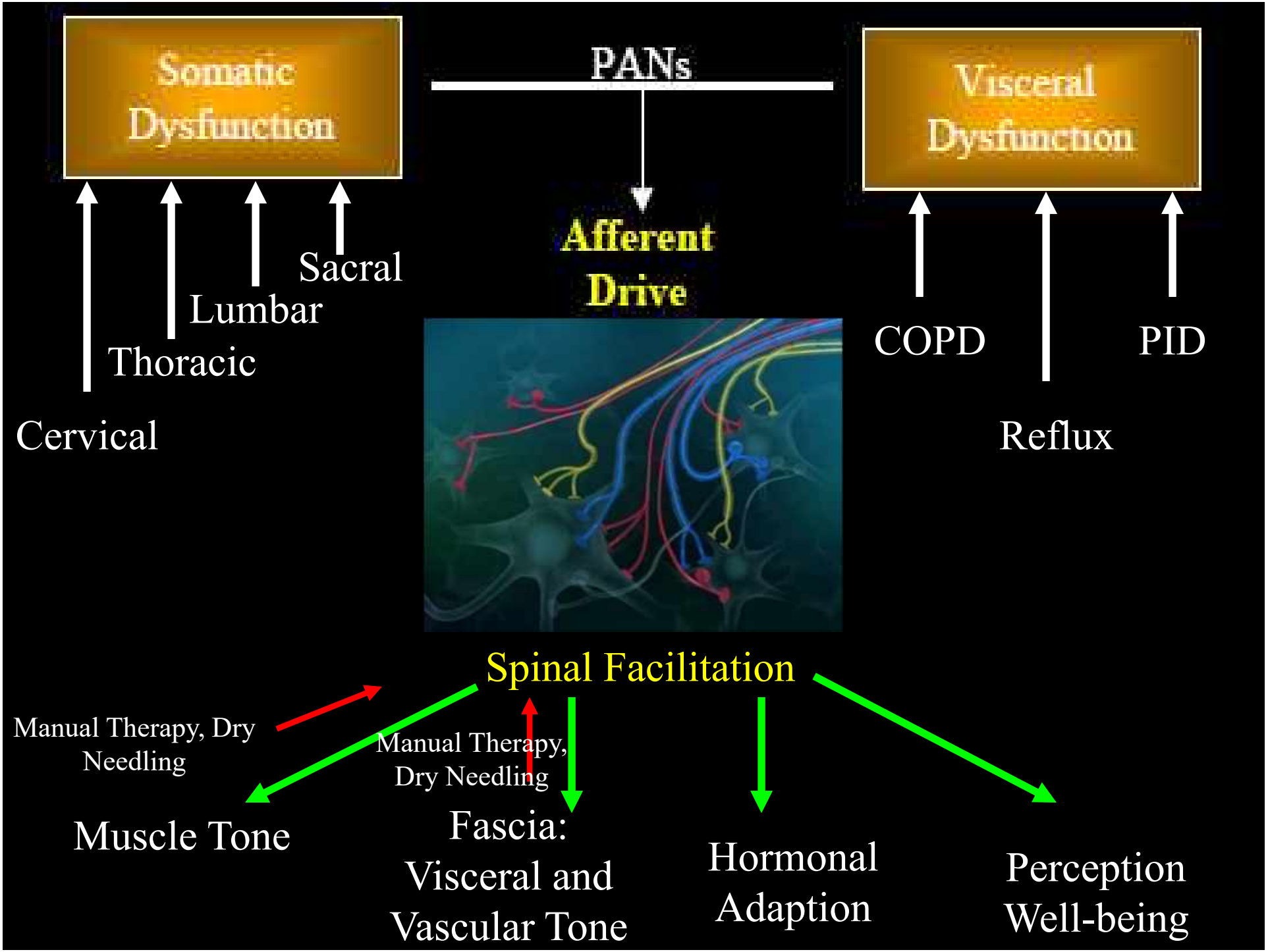
Somatic Dysfunction

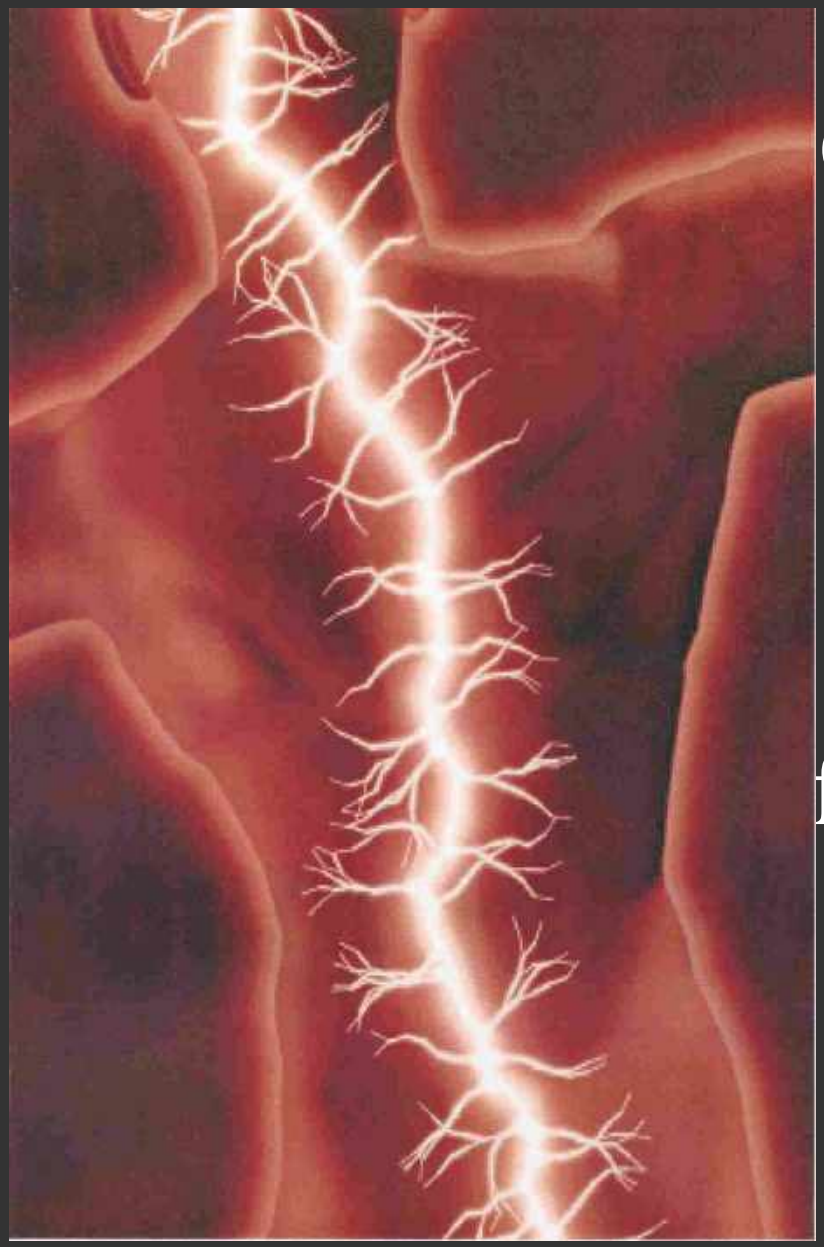
PANs

Visceral Dysfunction

Afferent Drive




Somatic Dysfunction
PANs
Visceral Dysfunction
Afferent Drive
Sacral
Lumbar
Thoracic
Cervical
COPD
PID
Reflux
Spinal Facilitation
Manual Therapy, Dry Needling
Manual Therapy, Dry Needling
Muscle Tone
Fascia: Visceral and Vascular Tone
Hormonal Adaption
Perception Well-being



Clinical Diagnosis of a Sensitized Segment Using Surface Anatomy and Palpation: Relevance for Chronic Myofascial Pain

ALGORITHM

- Phase I: Identify the immediate cause of pain
- Phase II: Diagnosis of Spinal Segmental Sensitization
- Phase III: Treatment
- Phase IV: Diagnosis and removal of perpetuating and etiological factors

IMMEDIATE CAUSE OF PAIN

1. Point with one finger where the pain is most intense
2. Find point of maximum tenderness
3. Reproduction of pain

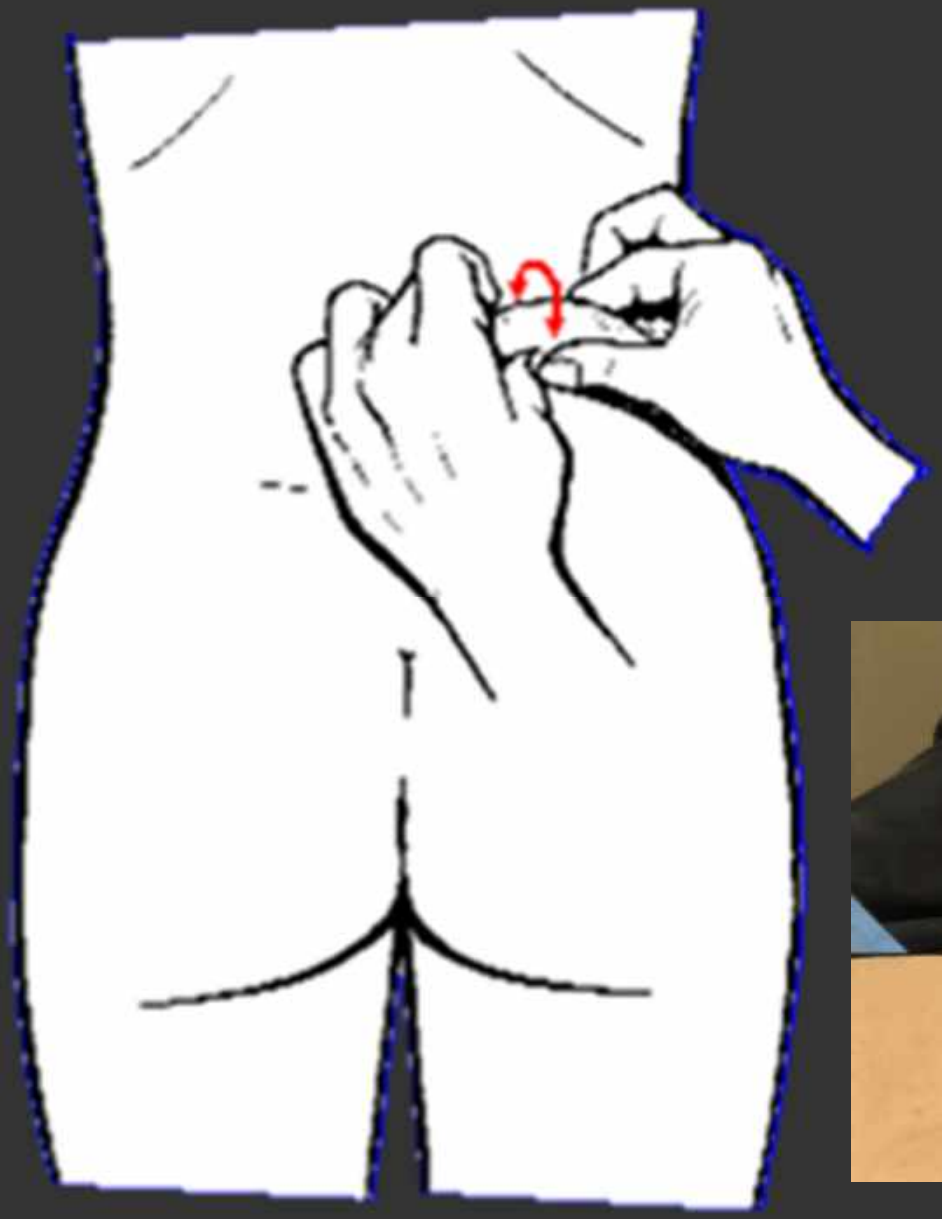
Latissimus dorsi (C6-C8)

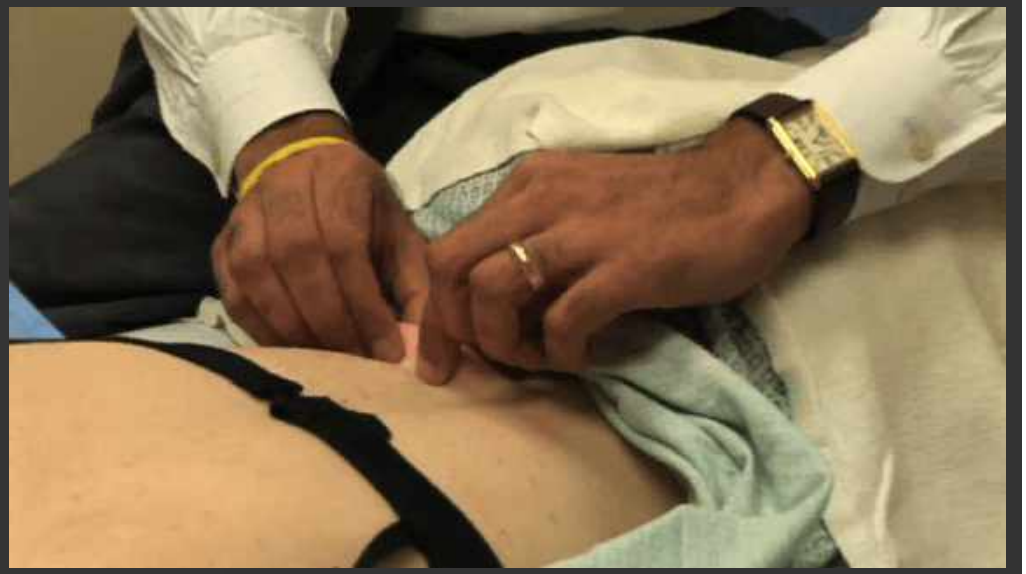
Courtesy Marta Imamura

PHASE II

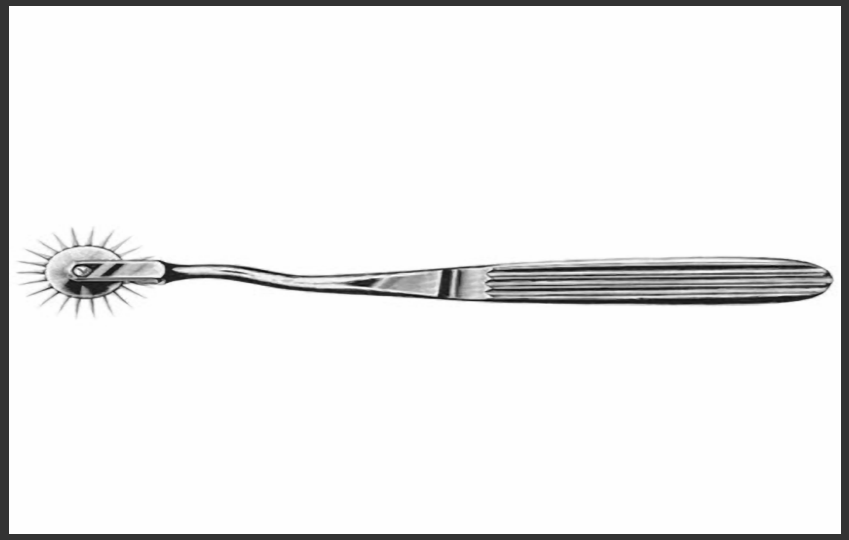
DIAGNOSIS OF SPINAL SEGMENTAL SENSITIZATION

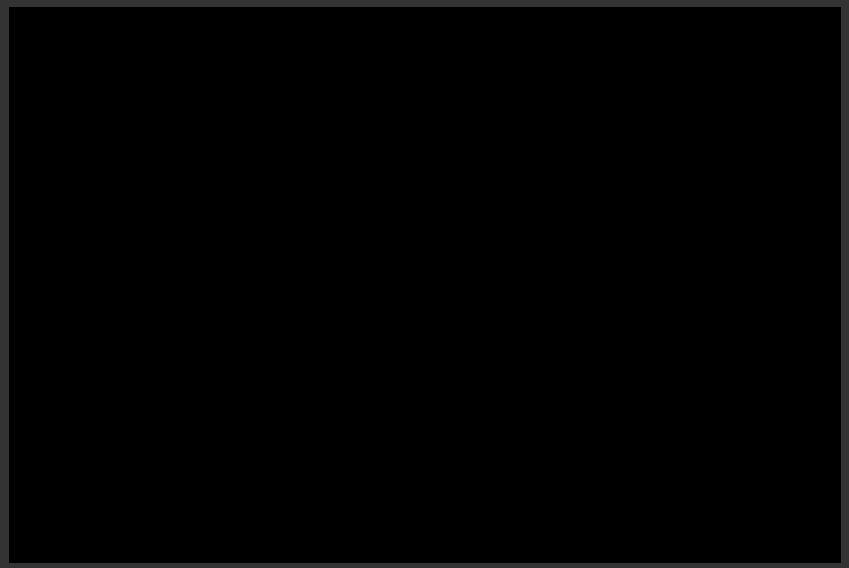
PINCH & ROLL: Allodynia

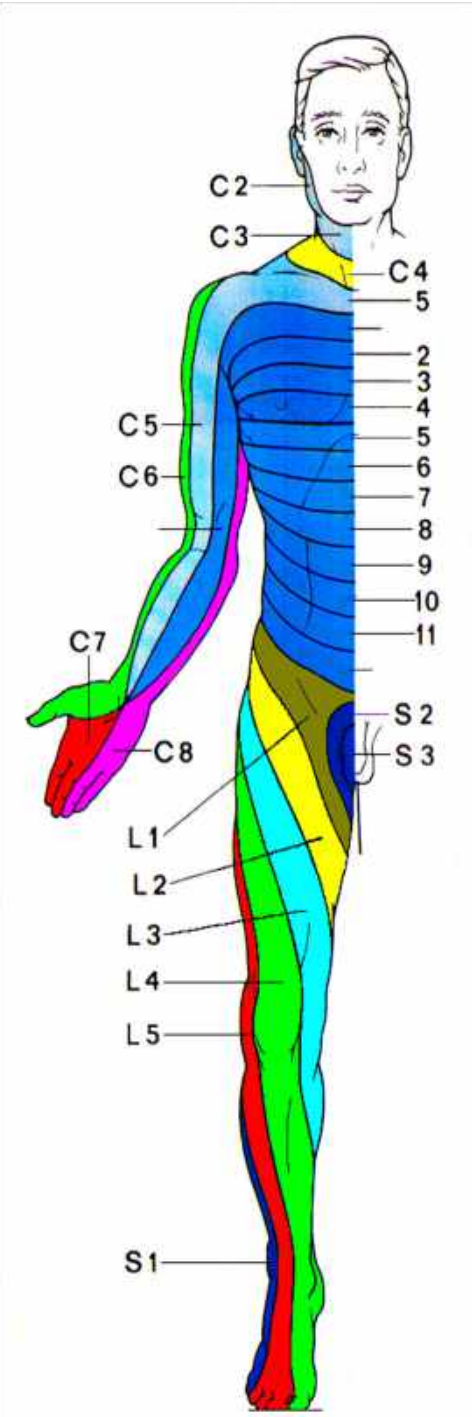




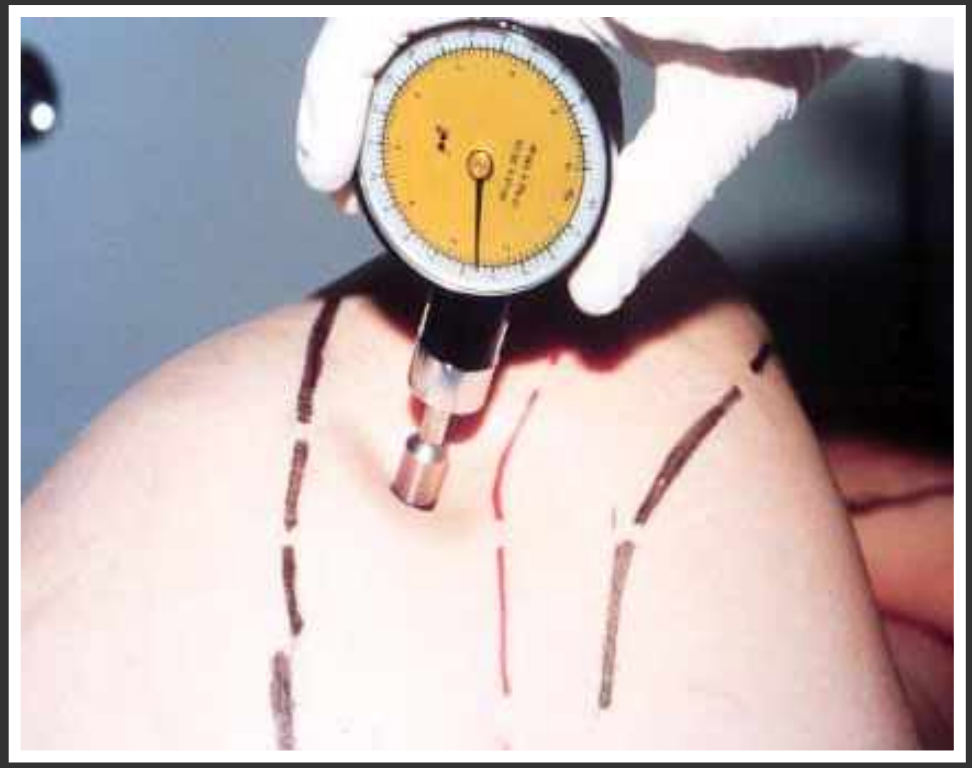
Waternberg pinwheel: Hyperalgesia







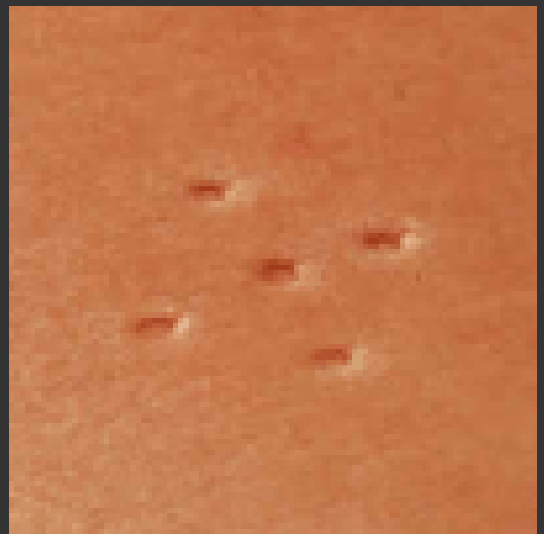
ALGOMETRY

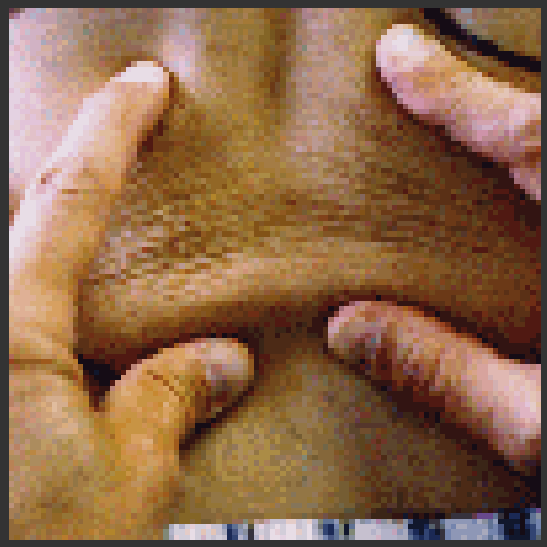


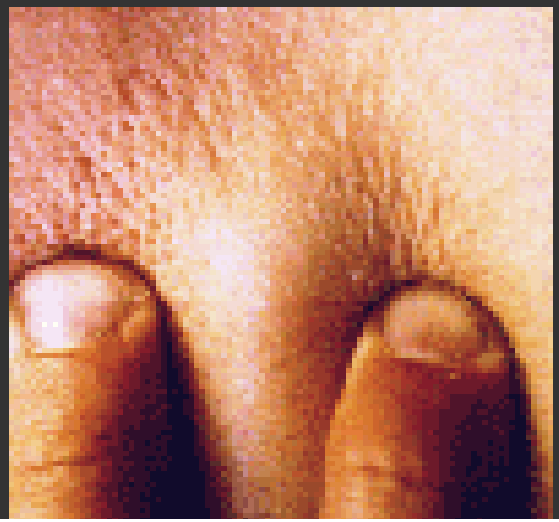
Fischer, A.A. Pain 30: 115-126, 1987

Standard values, validity and reproducibility.

Signs of SSS







MOTOR

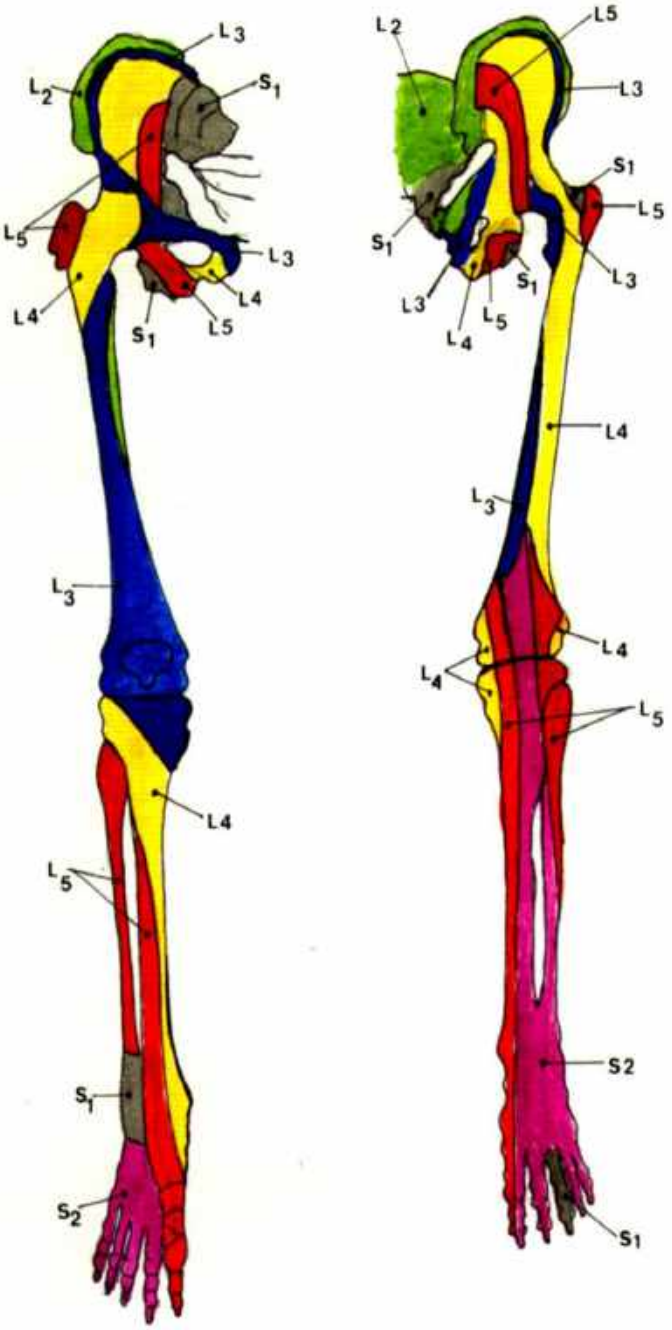
MYOTOME

Latissimus dorsi (C_6-C_8)

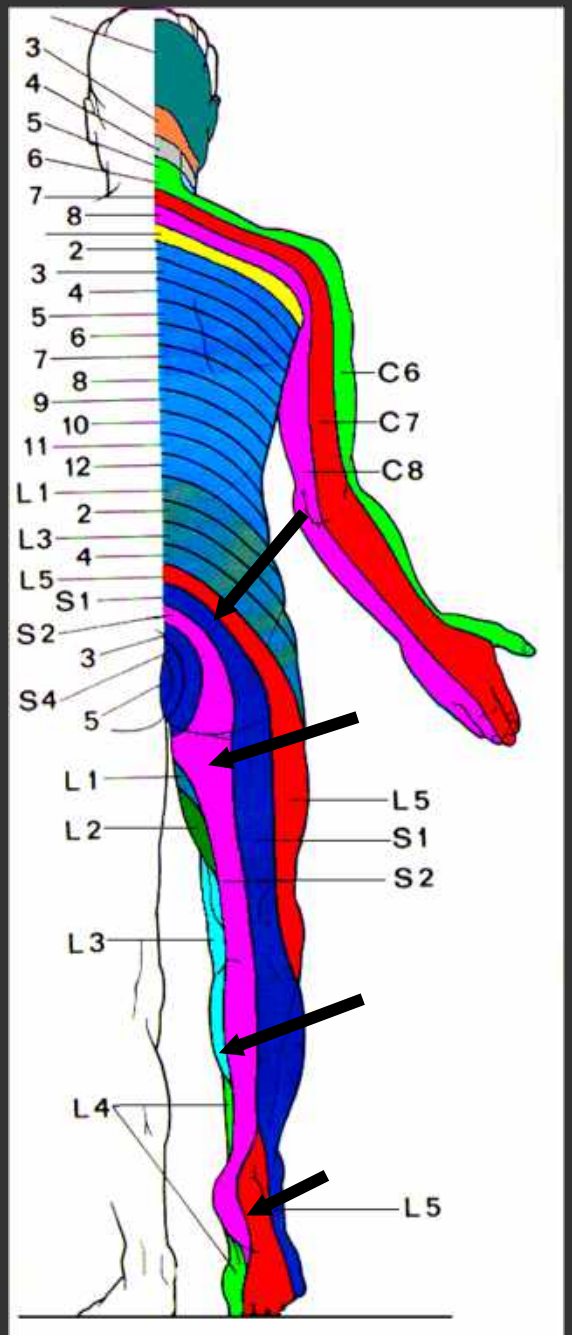
- Point tenderness
- Algometry
- Reduced threshold to muscle palpation

SCLEROTOME

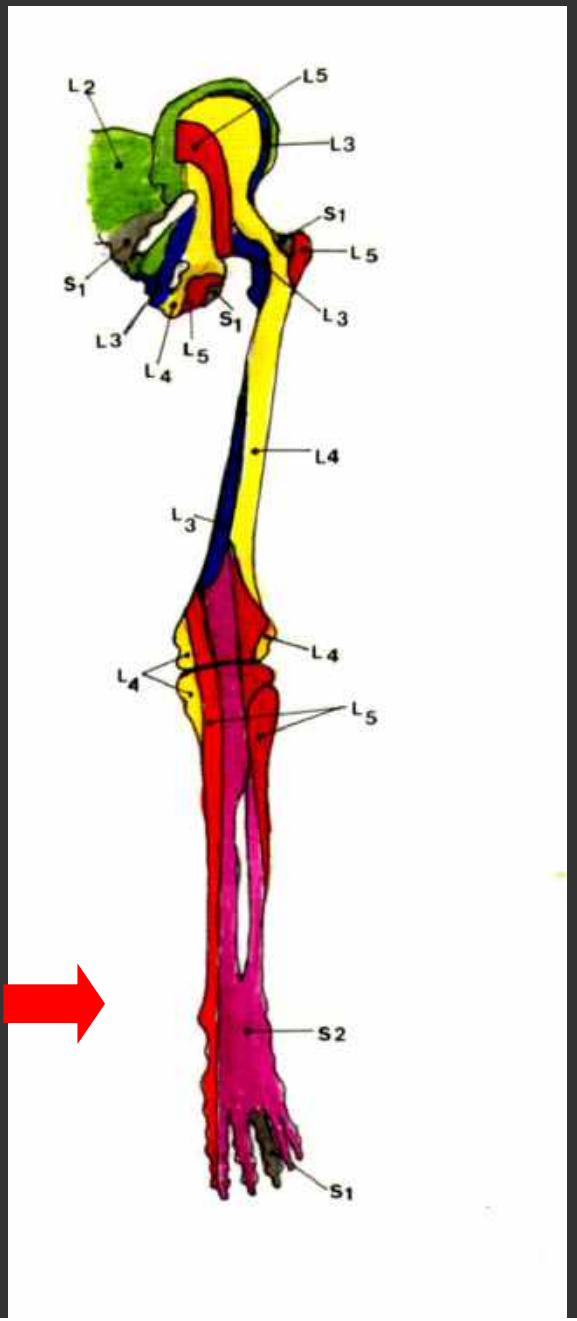
- Supraspinous lig
- L4: pes anserinus
- L5: Major trocanter
- S1: SIJ
- S2: Plantar fascia



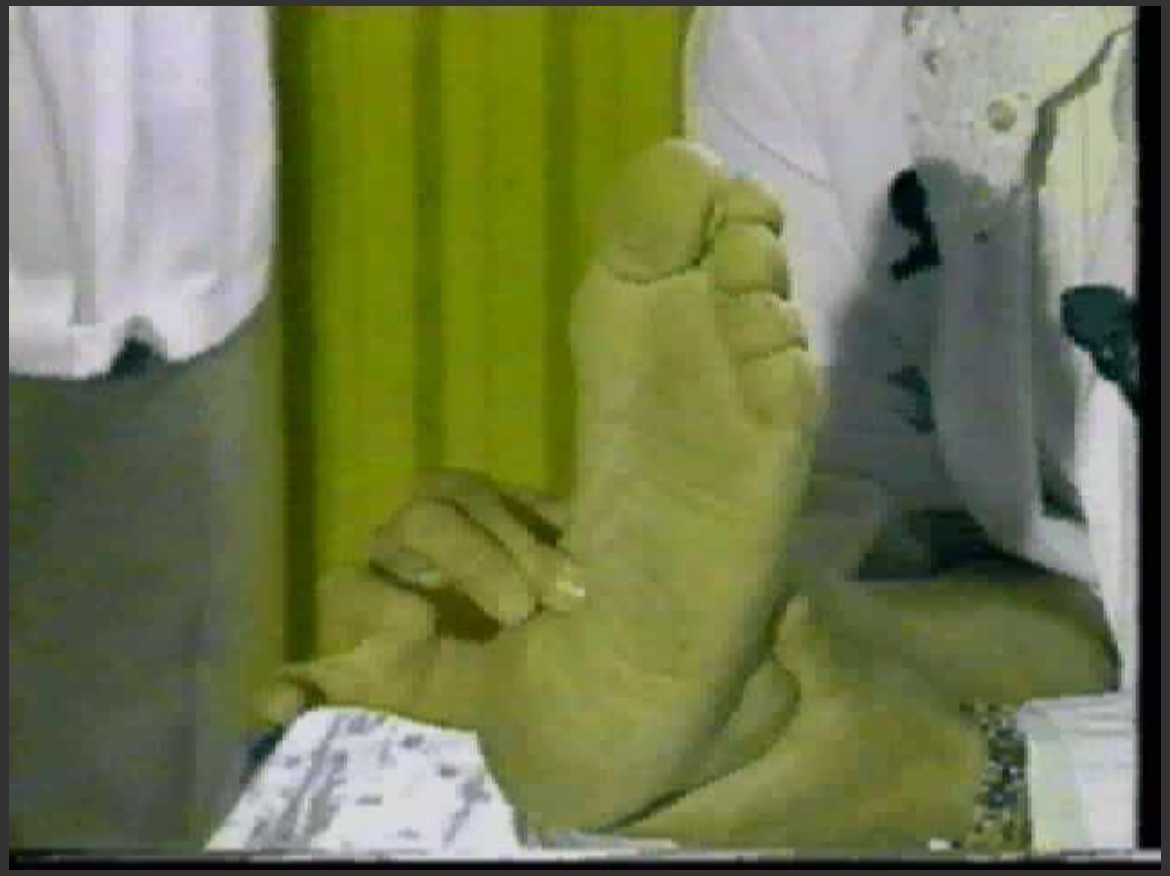
Dermatome



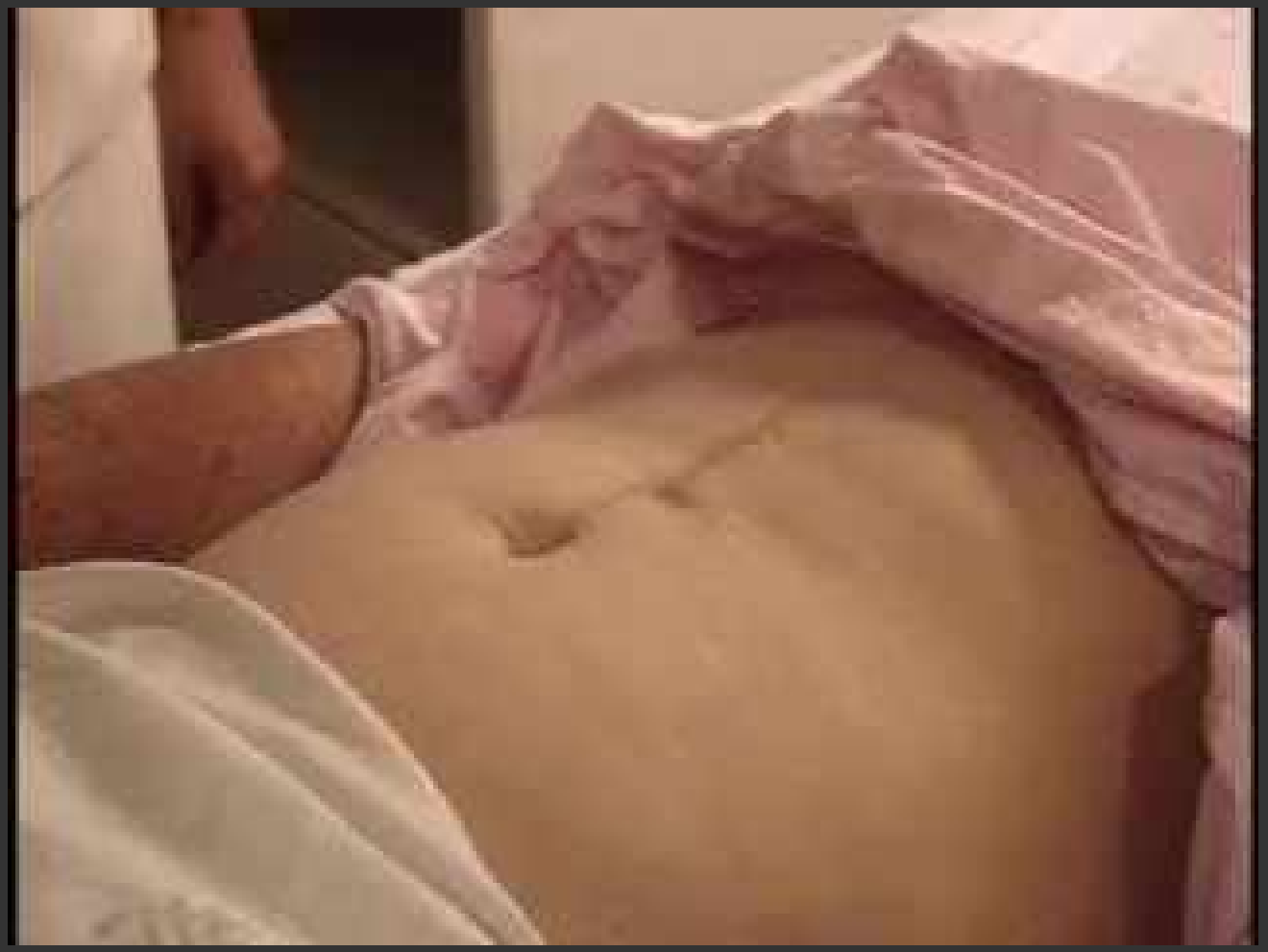
Sclerotome



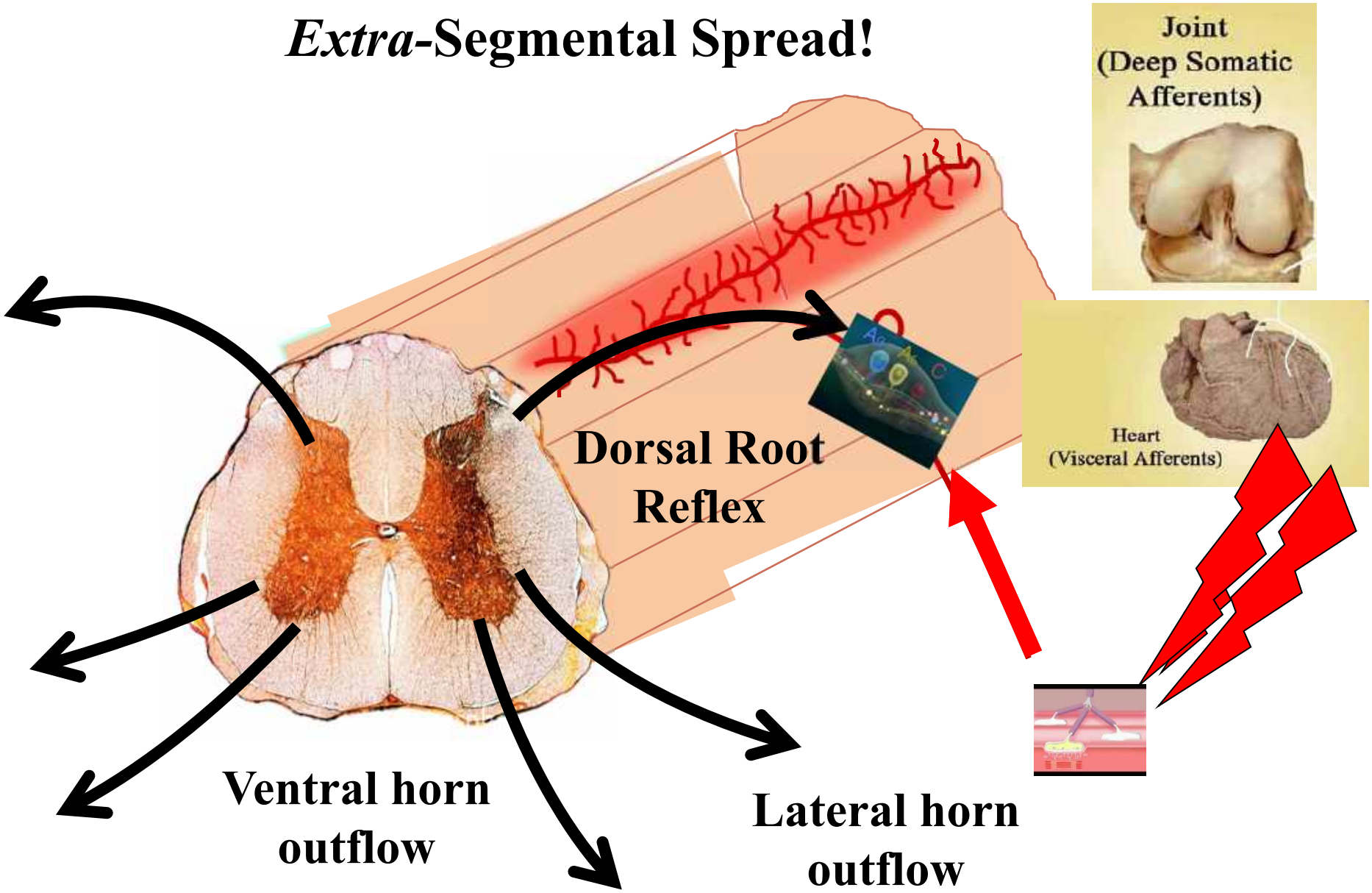
?Plantar Fasciitis?



Chronic Pain and Signs of Segmental Sensitization



Sensitized Dorsal Horn Neurons Demonstrate *Extra*-Segmental Spread!



Neuro-modulating the Pain Matrix:

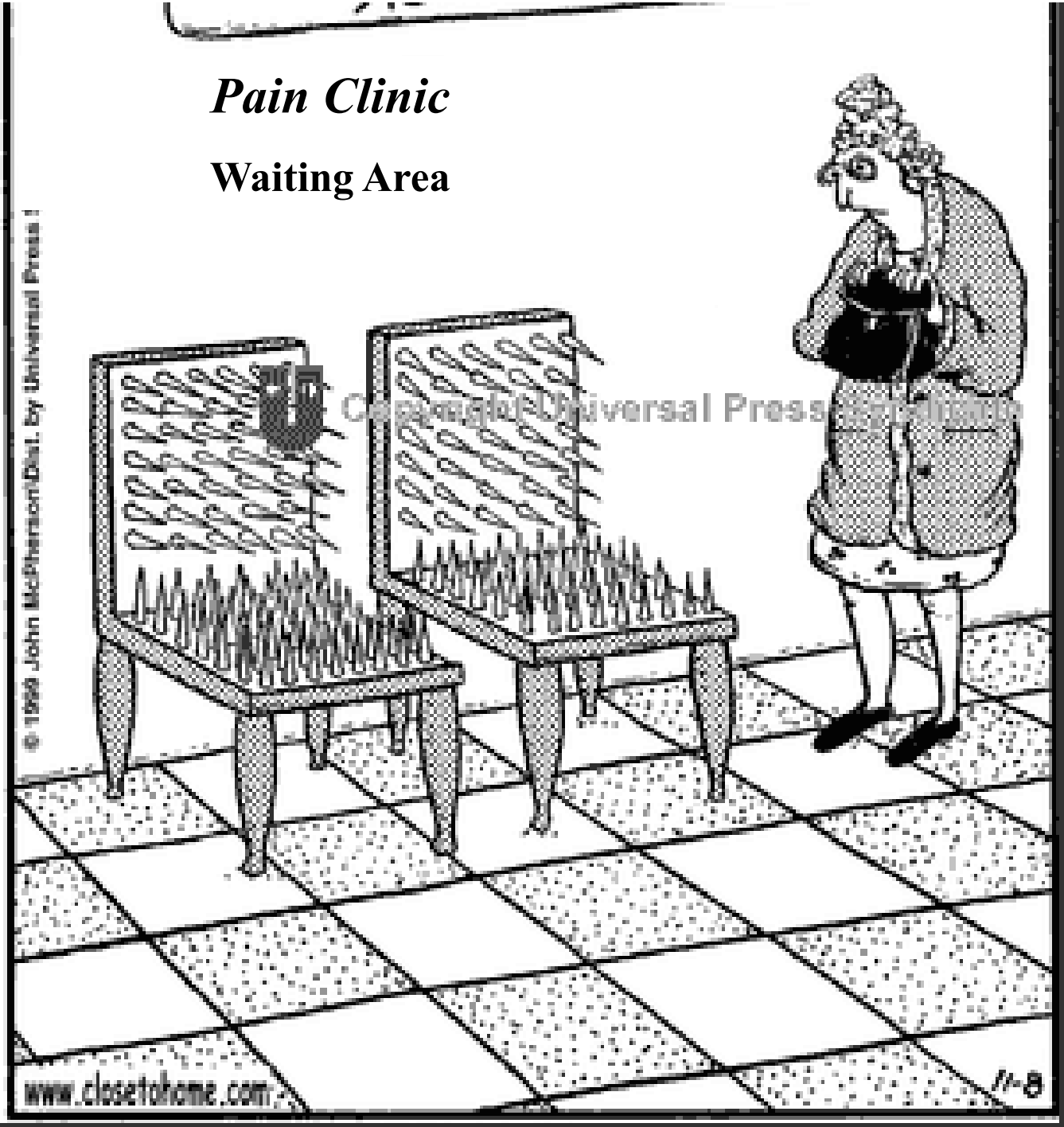
Dry Needling, Injection, Acupuncture and Electrical Stimulation Techniques for *Desensitizing* the Sensitized Segment and Deactivating Chronic MTrPs

Getting to the "Point":
Dry Needling, Trigger Points and Desensitization

Some clinicians start dry needling right away…

Pain Clinic

Waiting Area



Dry needling, Intramuscular Stimulation, Trigger Point Acupuncture, etc….

Where do you put the needles and how do you manipulate them?

Neuro-modulating the Pain Matrix:

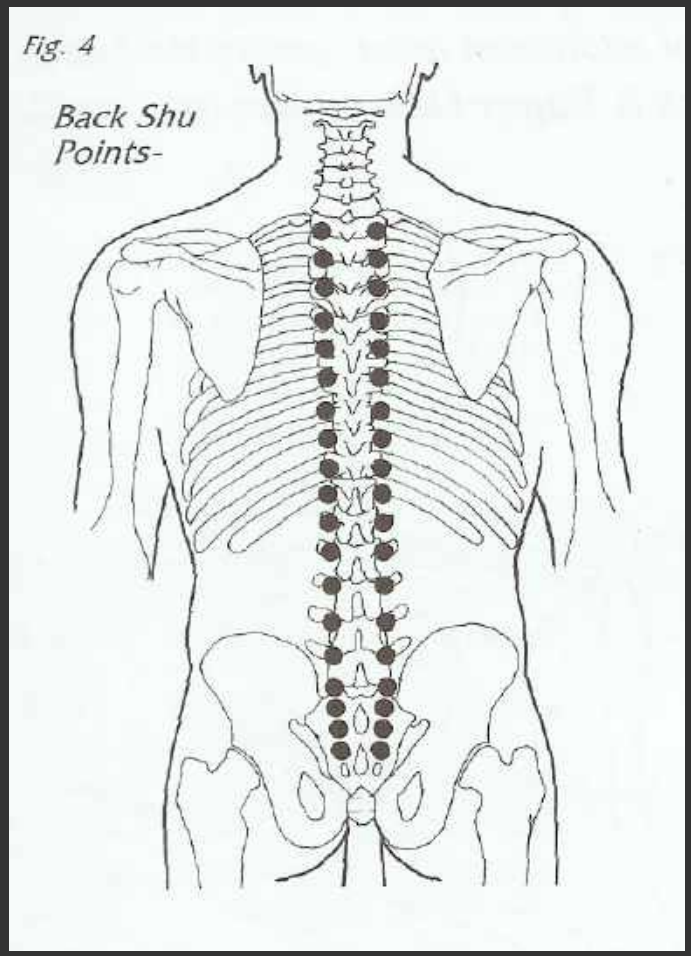
Concentrate on the sensitized segment (central) and the related structure (peripheral) corresponding to the immediate cause of pain

SEGMENTAL DESENSITIZATION

MODALITIES:

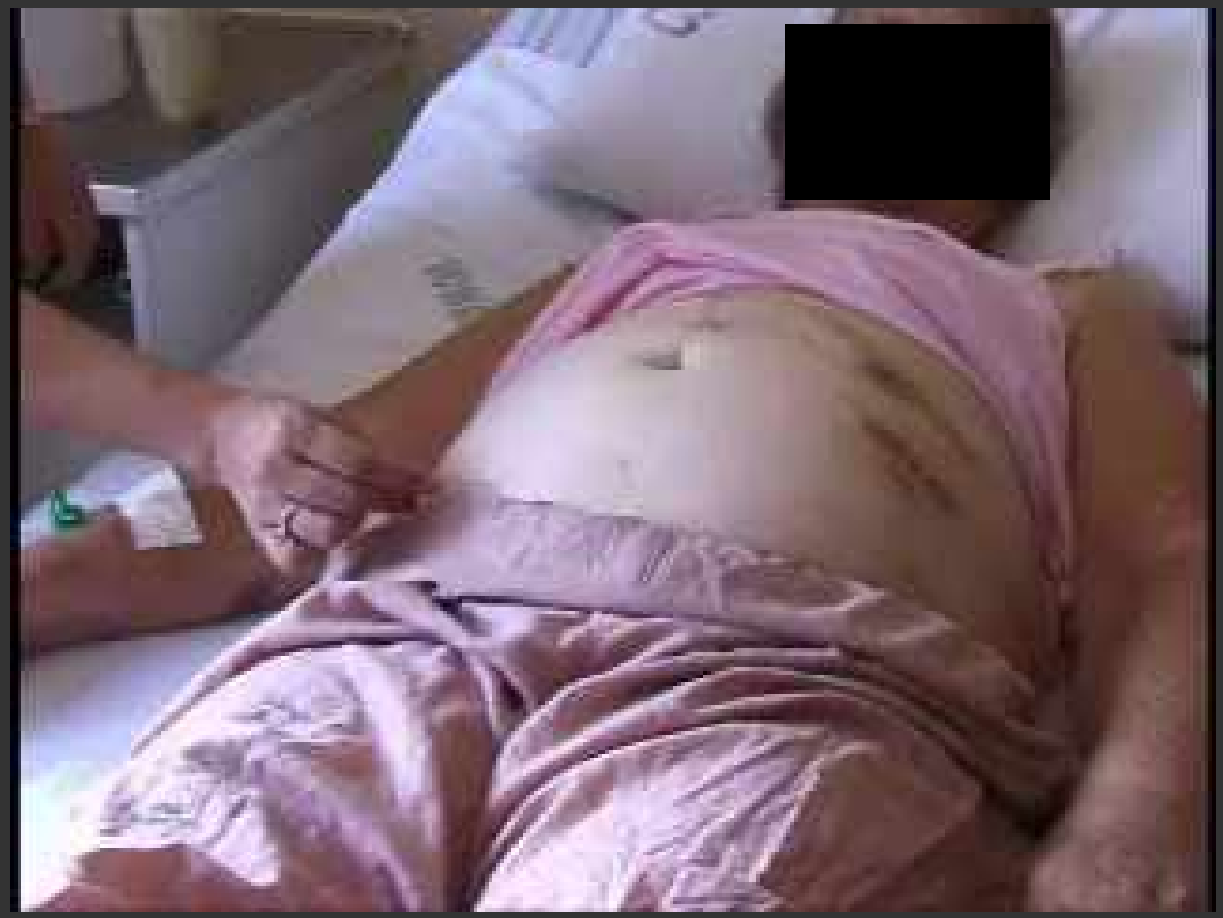
- Electrical Stimulation
- Dry Needling
- Electroacupuncture
- TENS
- Spray and Stretch

Point Stimulation

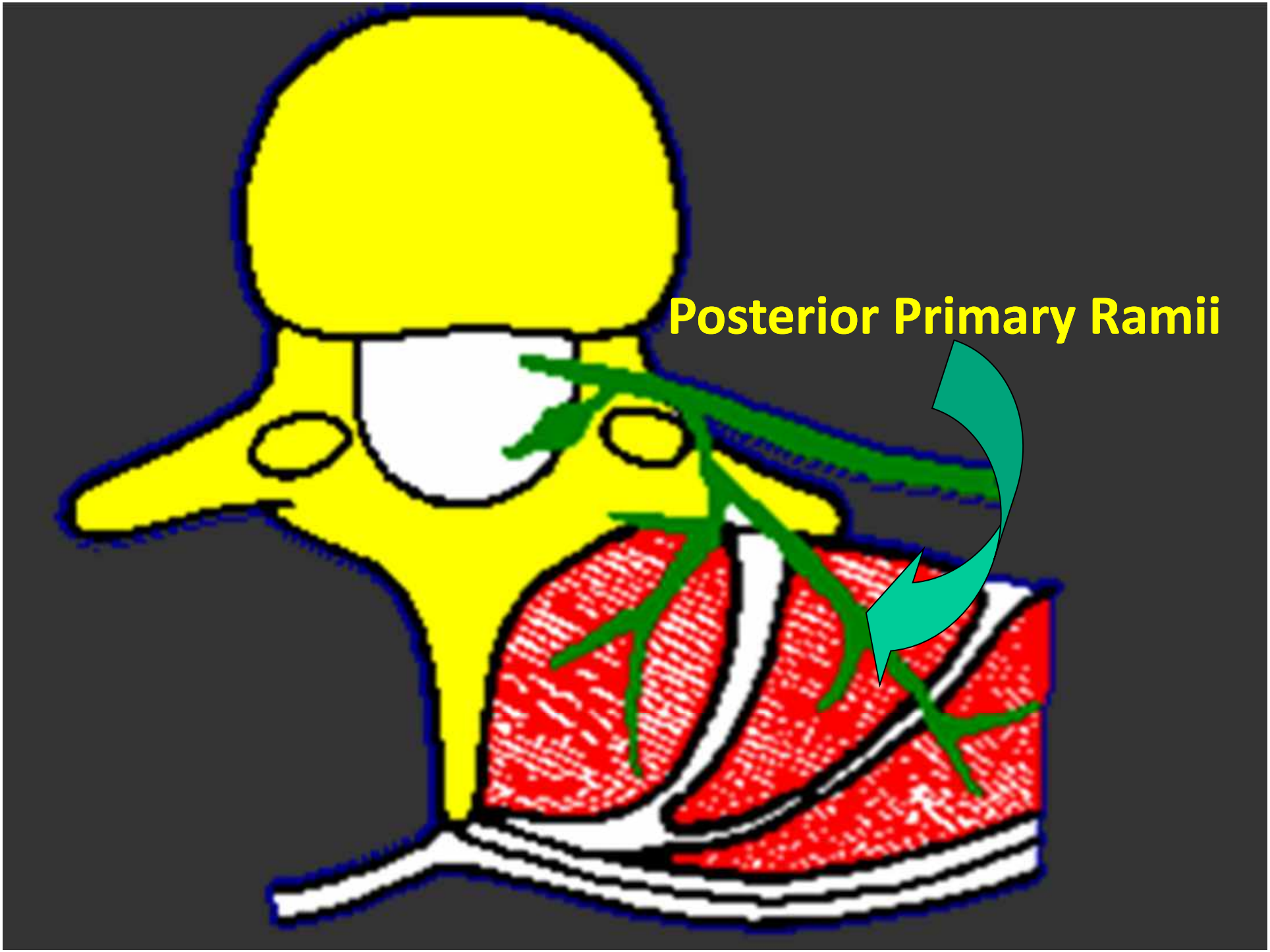


?Plantar Fasciitis?

Post-Desensitization

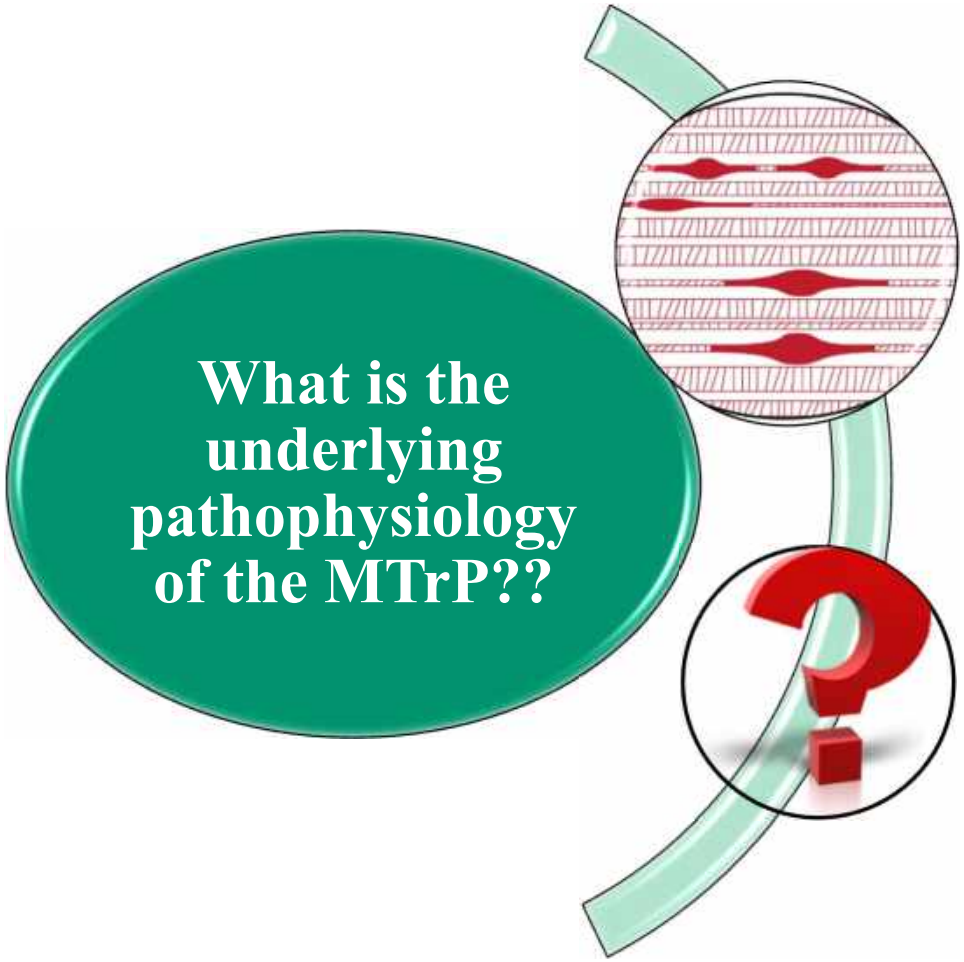


Paraspinal Needling of the Neuromatrix


Posterior Primary Ramii

We Should Deactivate MTrPs that could Re-sensitize the Dorsal Horn

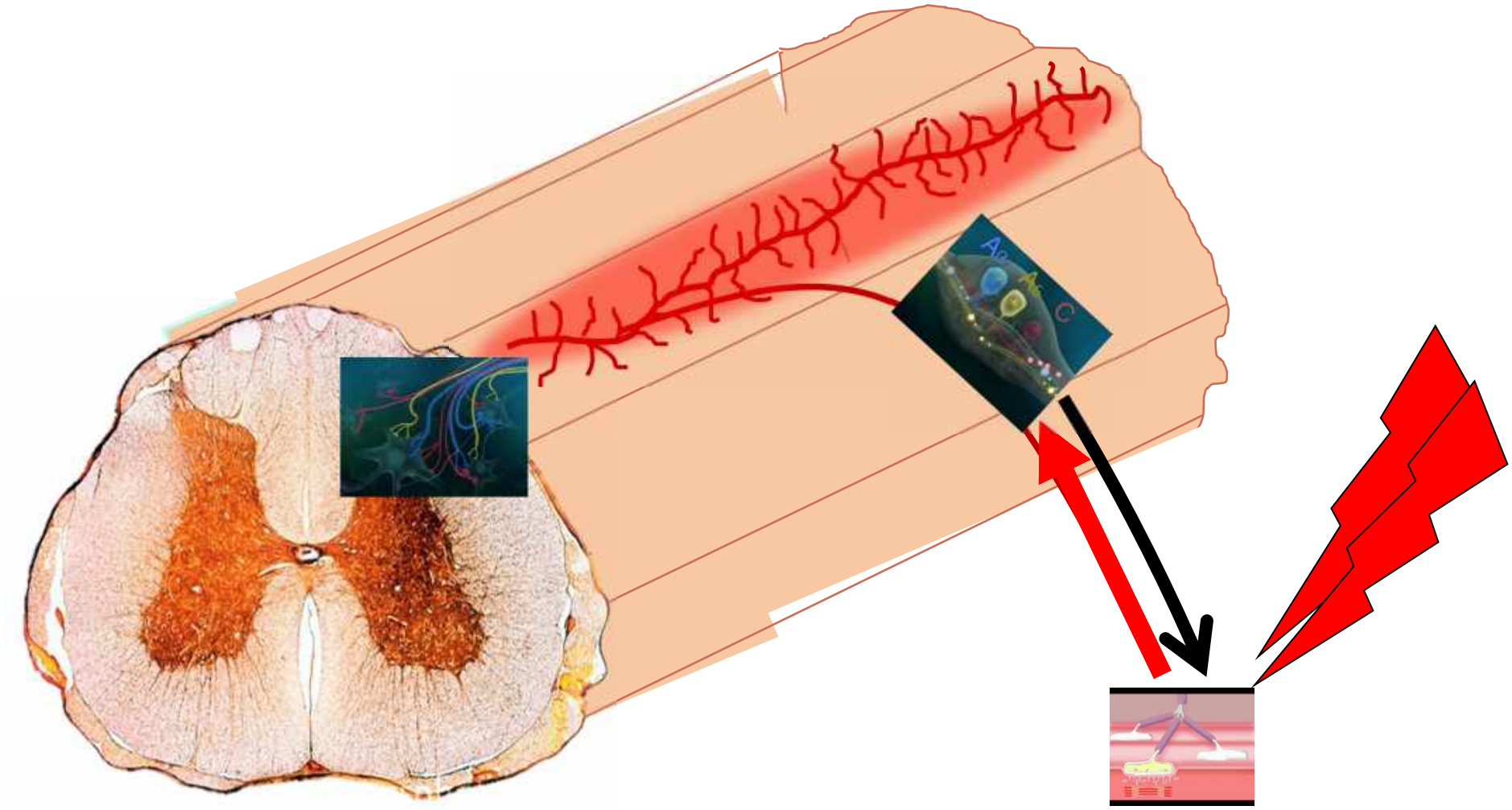
Myofascial Pain
Central Outstanding Question

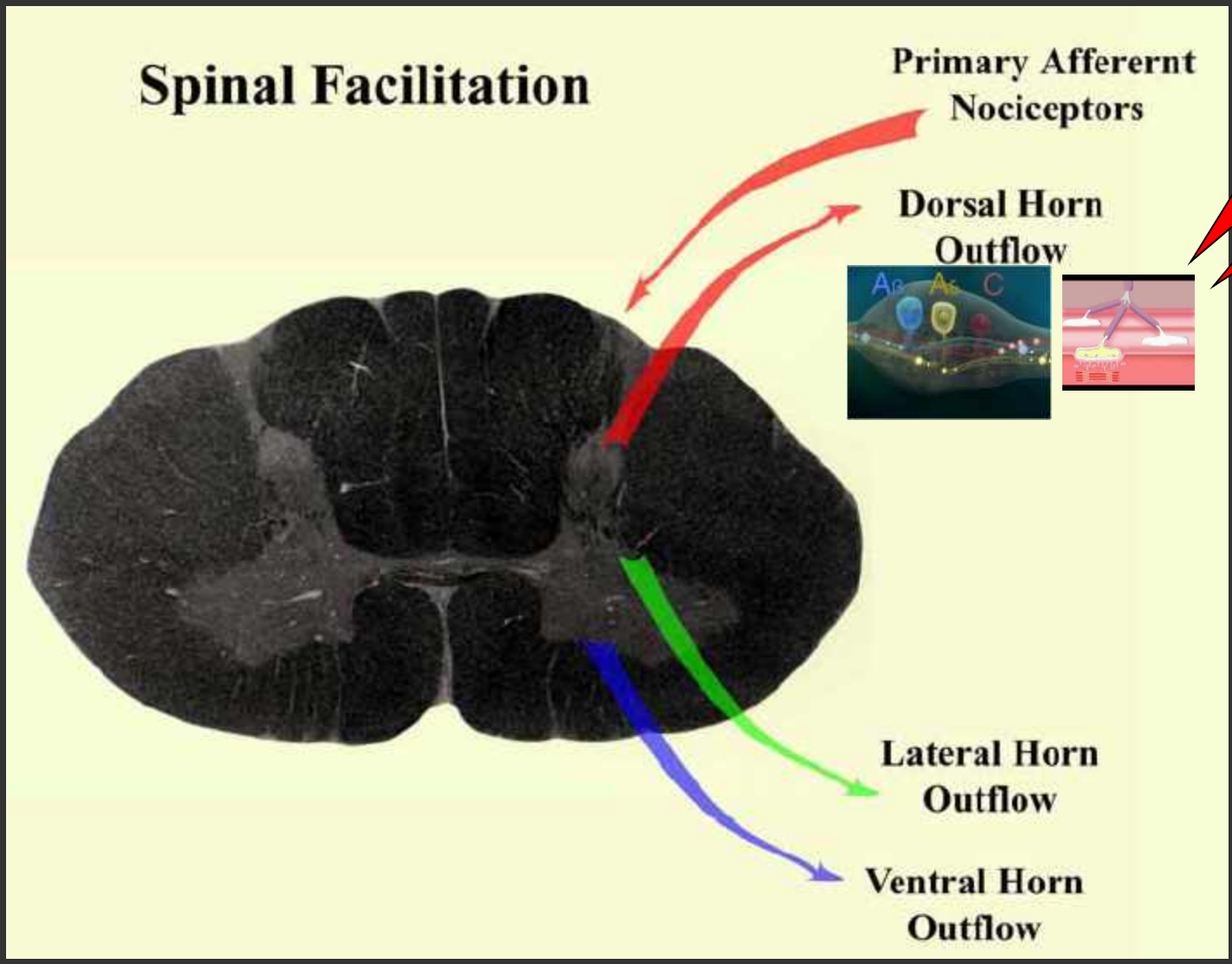


"Is the MTrP the **primary pathology** in Myofascial Pain Syndrome (MPS) or is MPS a clinical manifestation of an underlying physiologic mechanism?"

Is the MTrP the "Cause or Effect"?

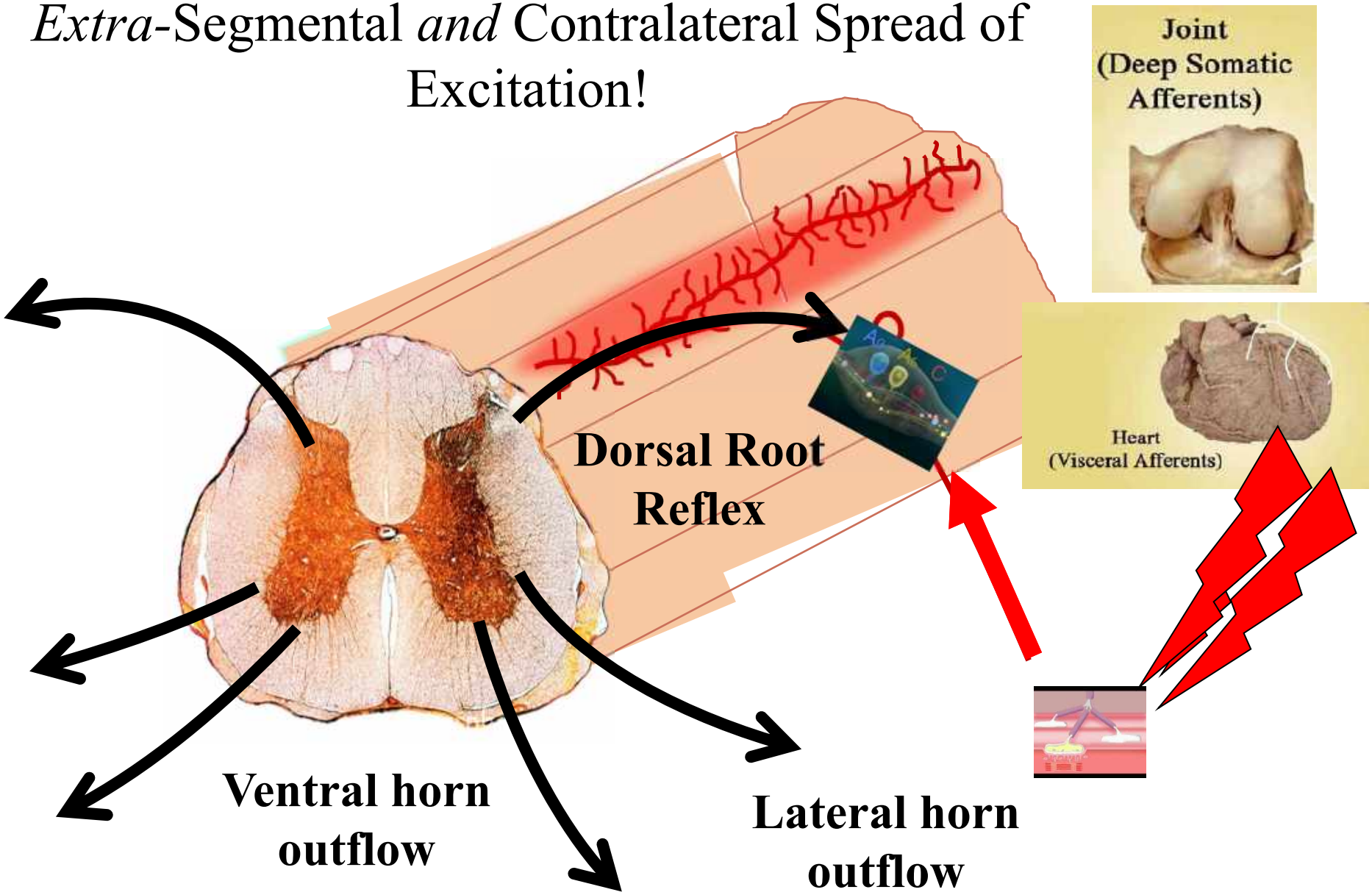
Sensitized Dorsal Horn Neurons Demonstrate *Extra*-Segmental Spread of Excitation!



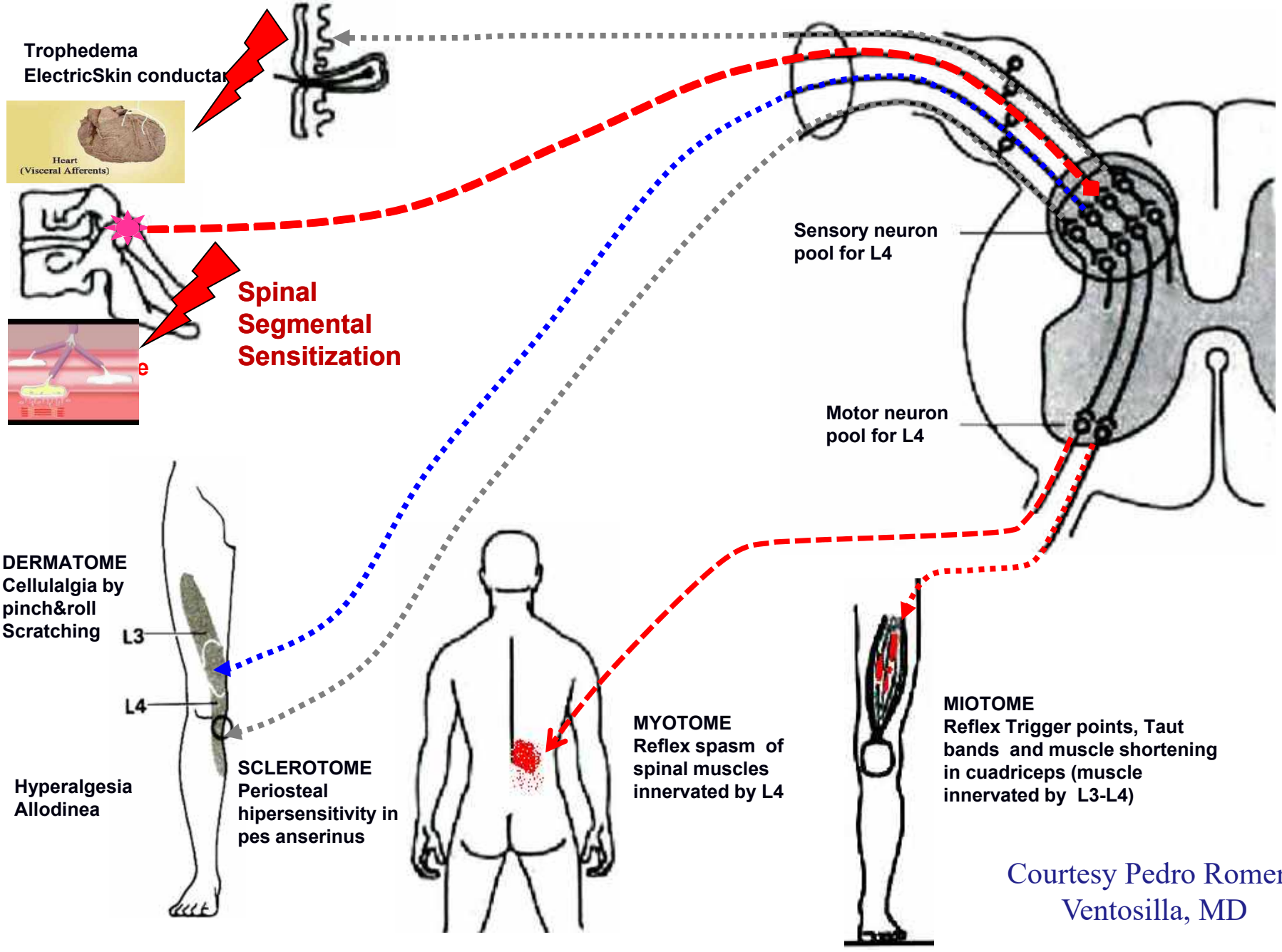


Courtesy Frank Willard,

Sensitized Dorsal Horn Neurons Demonstrate *Extra*-Segmental *and* Contralateral Spread of Excitation!

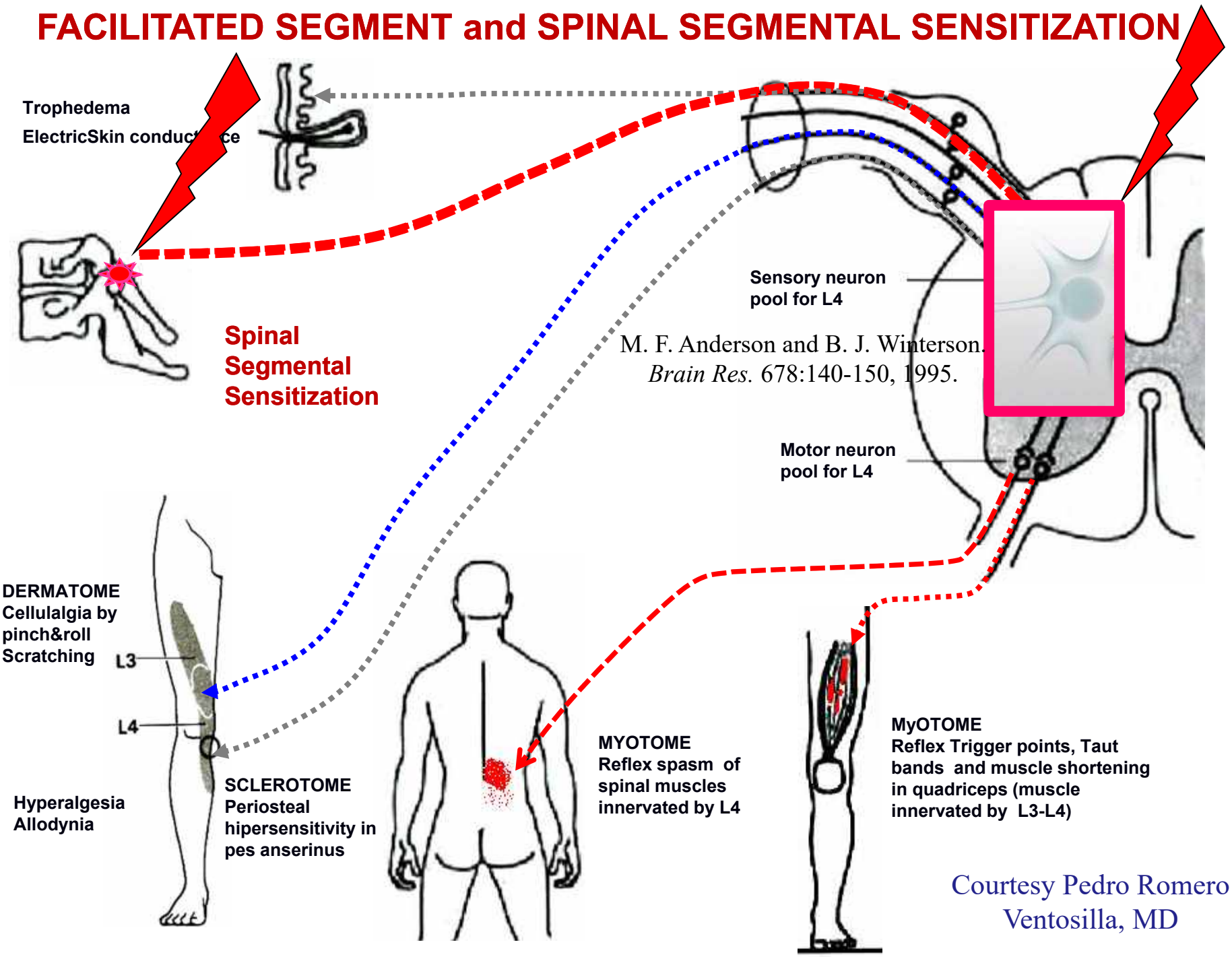


FACILITATED SEGMENT AND SPINAL SEGMENTAL SENSITIZATION



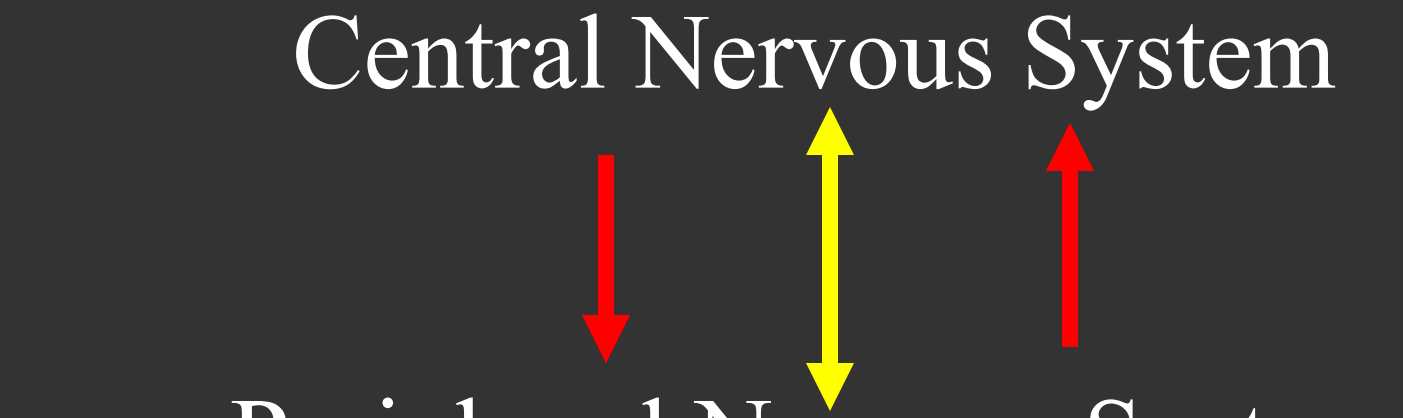
Courtesy Pedro Romero Ventosilla, MD

FACILITATED SEGMENT and SPINAL SEGMENTAL SENSITIZATION



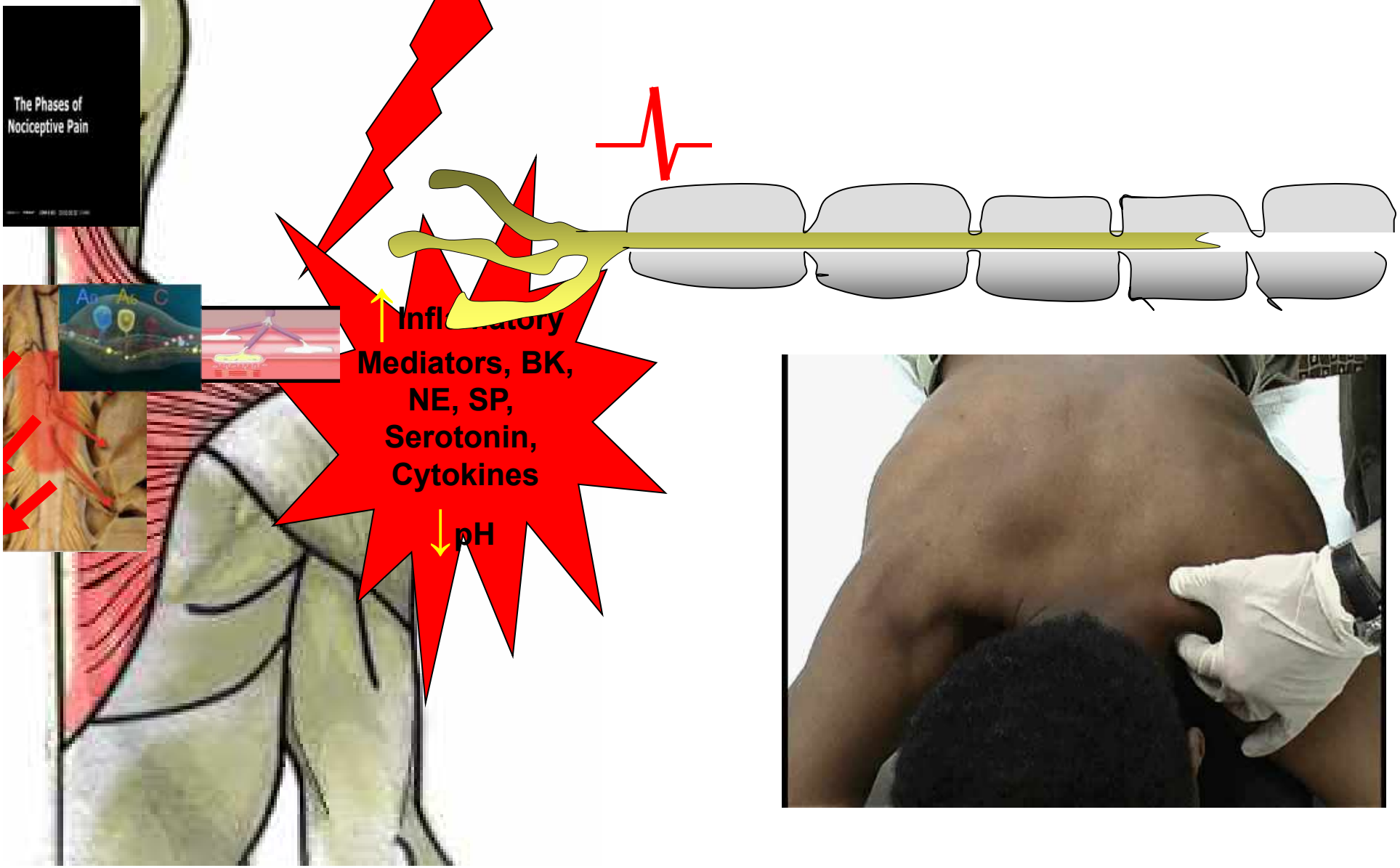
Courtesy Pedro Romero Ventosilla, MD

Integrated Neuromuscular Theory for Myofascial Pain Syndrome:

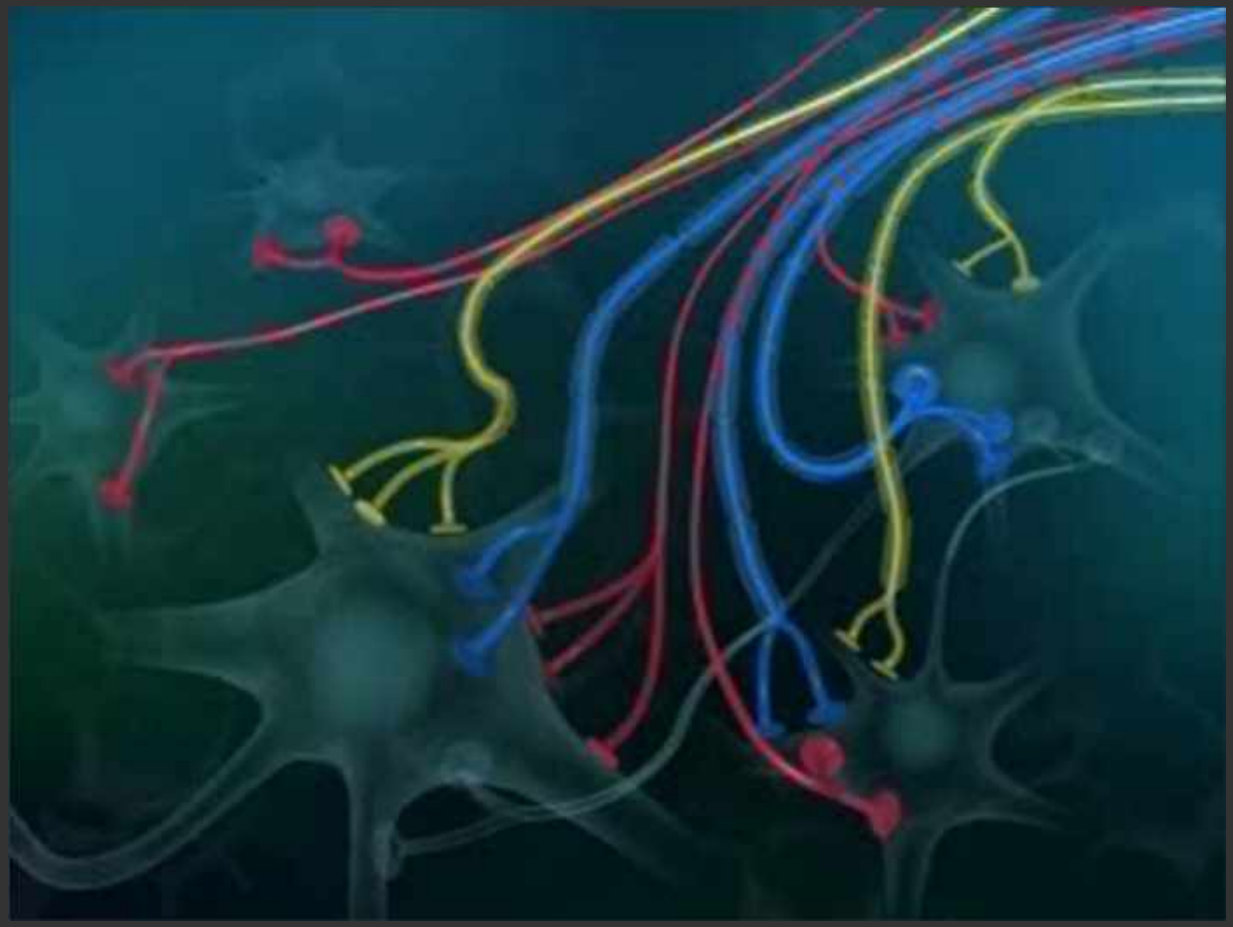


Integrated Neuromuscular Theory:

Central to Peripheral Sensitization



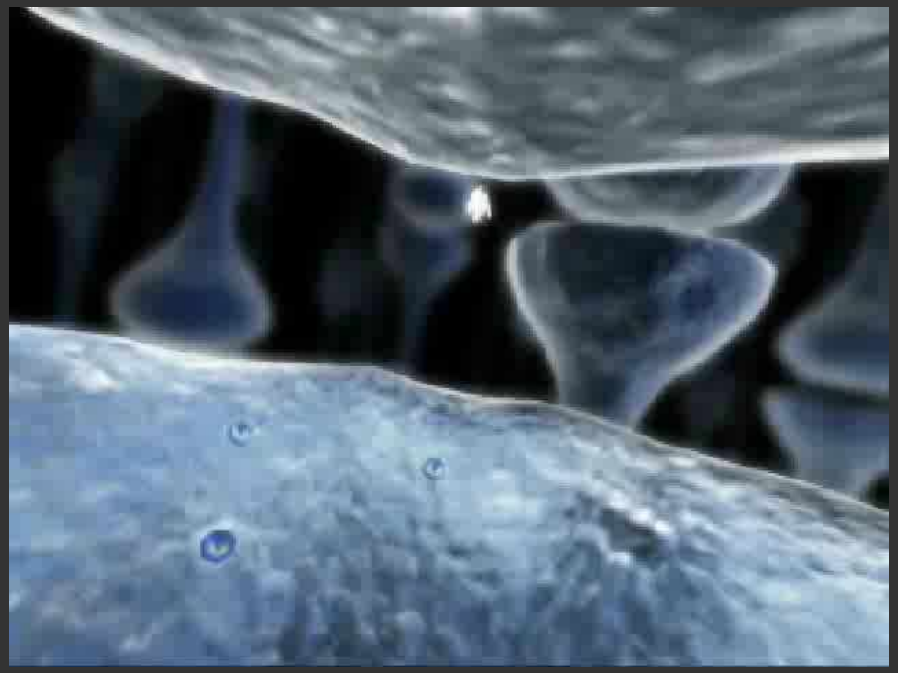
Integrated Neuromuscular Theory

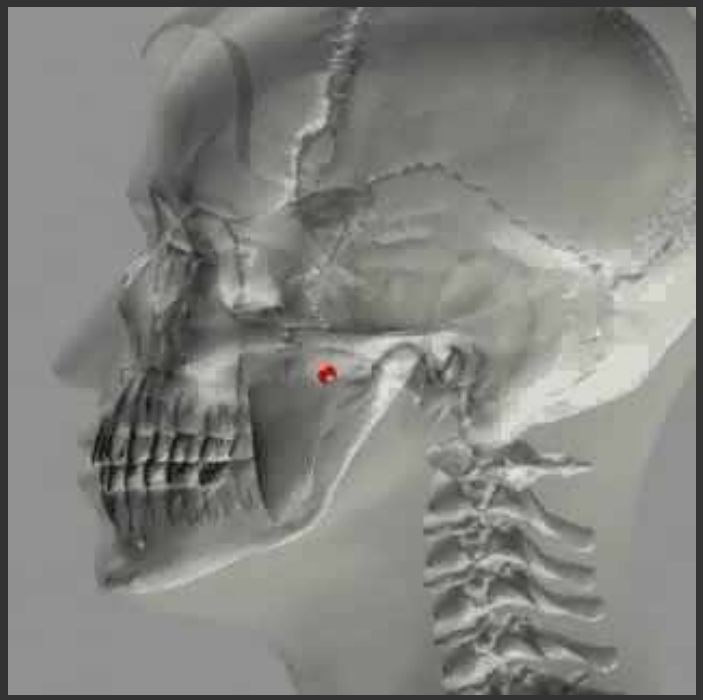


Active MTrPs function as dynamic foci of peripheral nociception that can initiate, accentuate, and maintain central sensitization

Integrated Neuromuscular Theory

…which will open previously ineffective connections - resulting in new receptive fields and referral of pain





Hans-Werner Weisskircher
www.trigger-point.com

Trigger Point Needling: Deactivation of Peripheral Nociceptive Foci

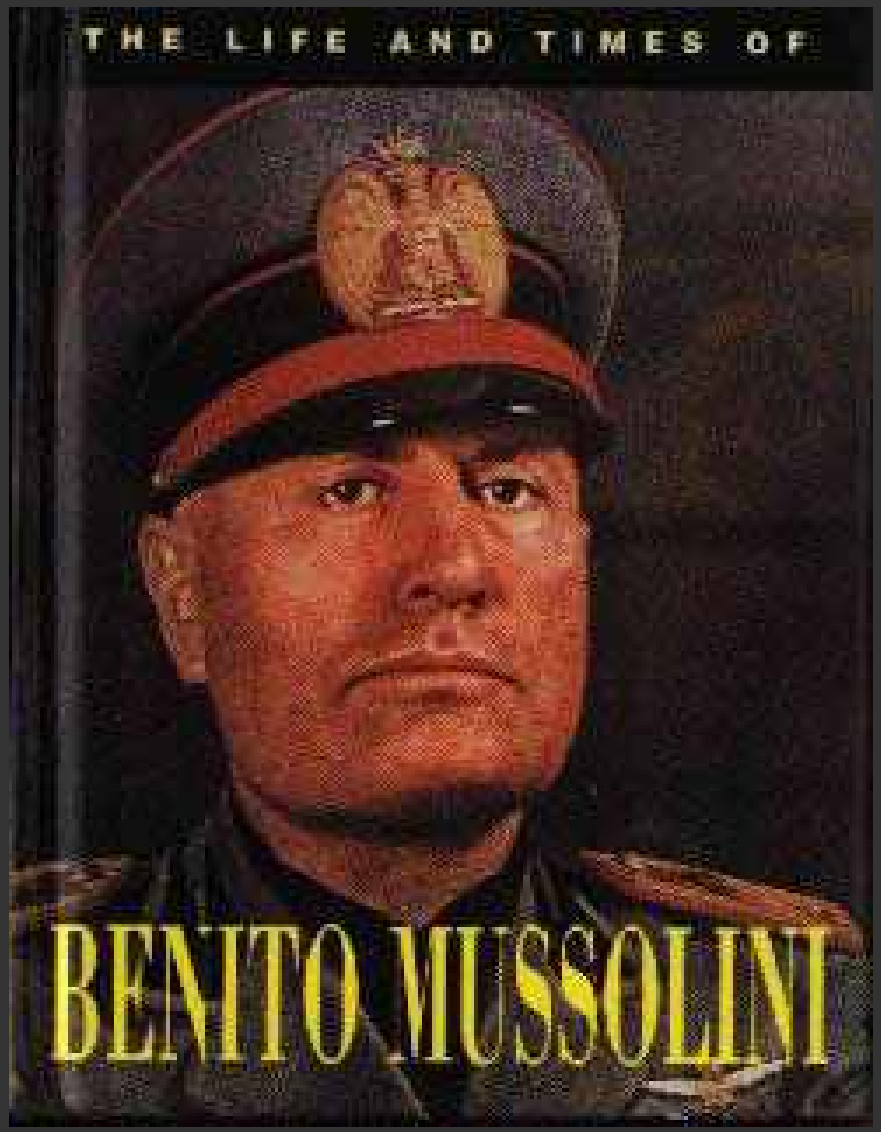
TrP

TrP

TrP

TrP

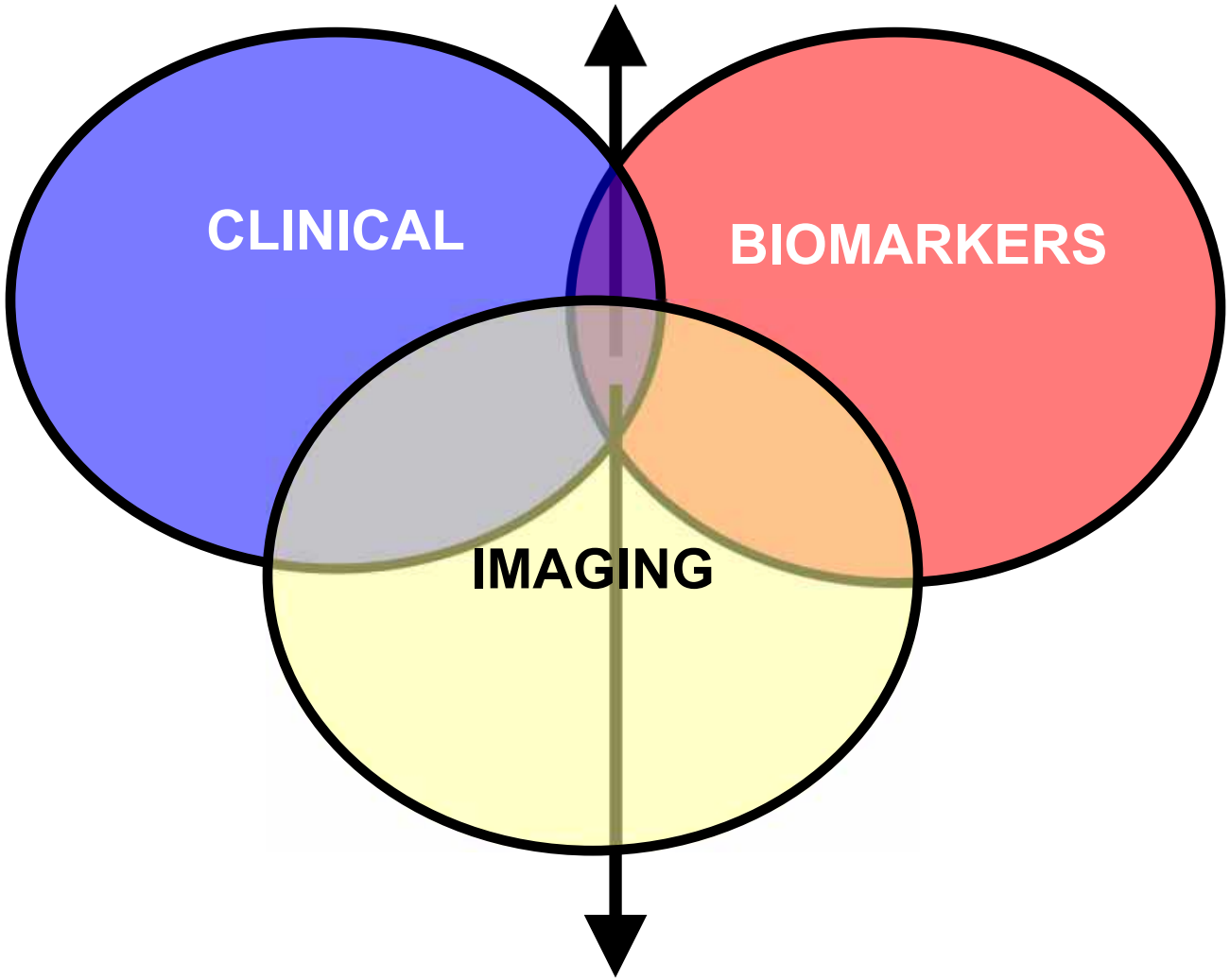
“I’m NOT a Myofascist!”



"I am a Myo-*fascia*-nado"

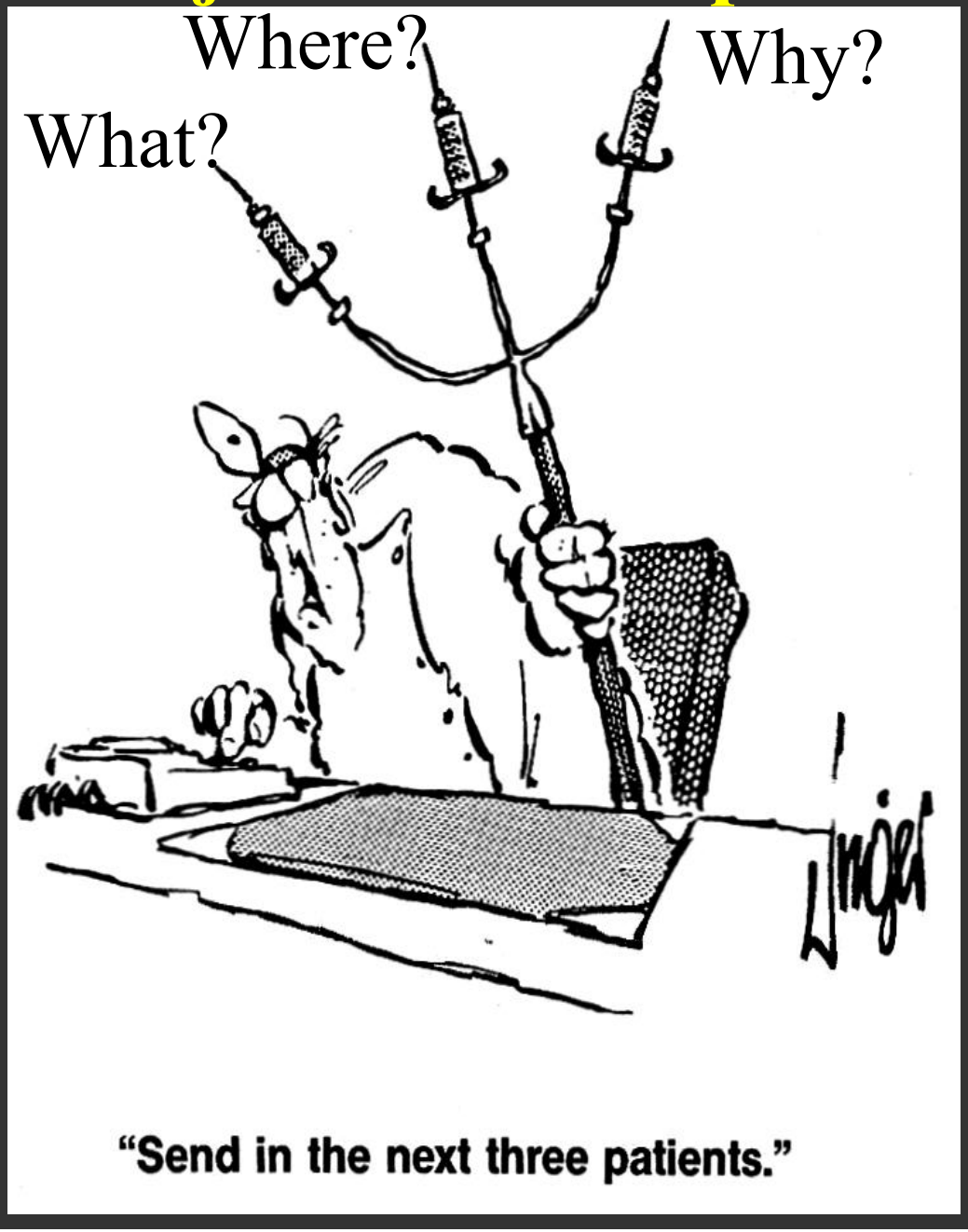
Preliminary Concepts Enabling Model Development

Mechanism-Based Diagnostic Criteria



Identify Treatment Targets and Objective Outcome Measures

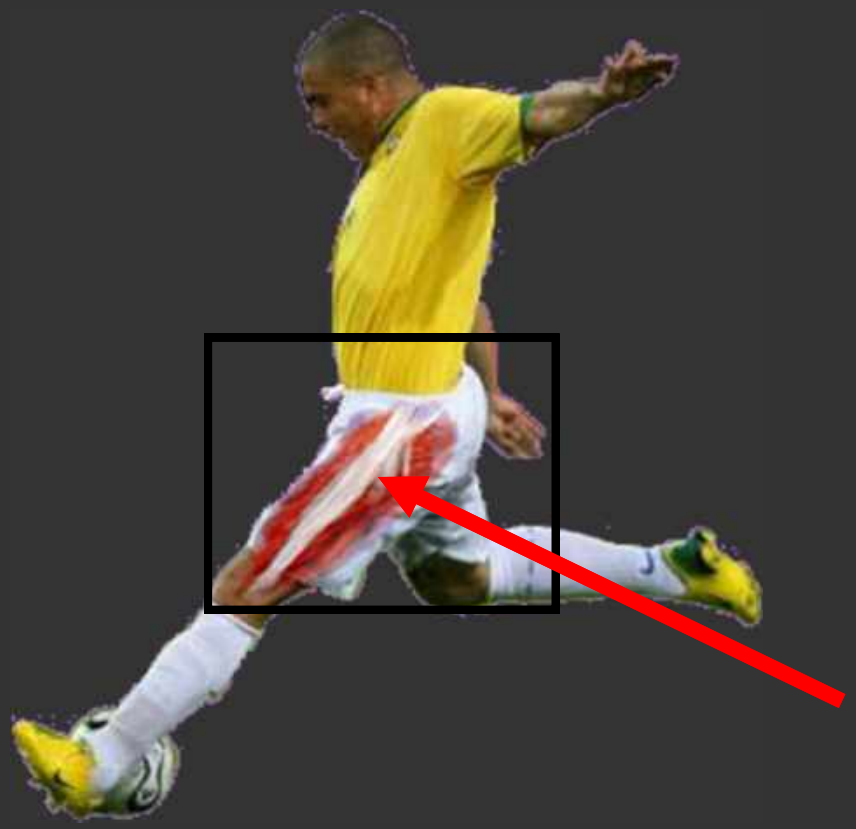
Injection Therapies



Mgmt of Neuro-musculoskeletal Pain and Sensitization

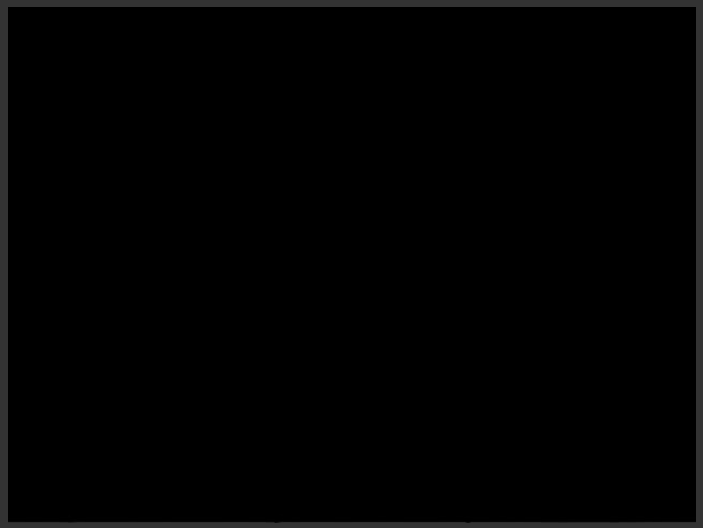
- **Diagnosis and workup**
  - ✓ Consider referral patterns of common MTrPs
  - ✓ Rule out other causes of pain by physical exam, imaging and laboratory tests, etc.
  - ✓ Palpate the muscle for active MTrPs

Mgmt of Neuro-musculoskeletal Pain and Sensitization

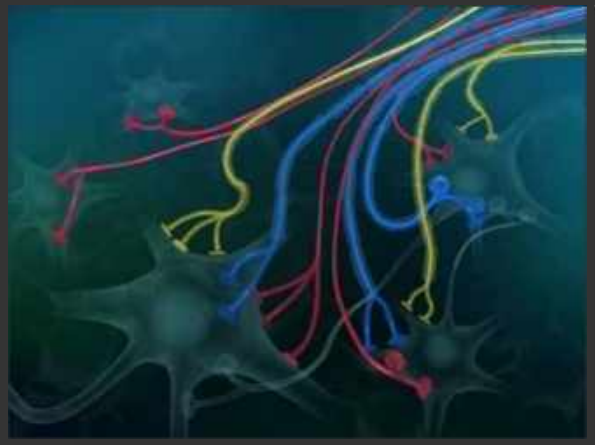


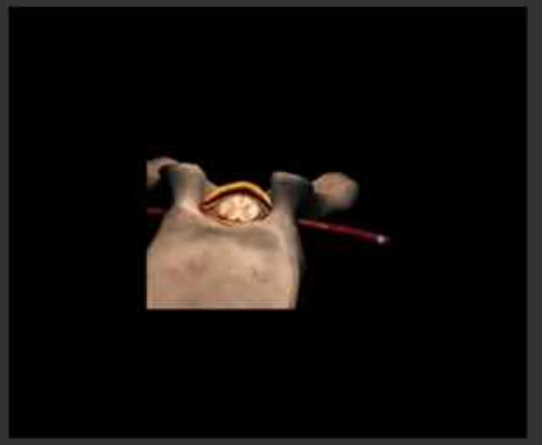
Modulation of the acidic pH, neuropeptides and pro-inflammatory cytokine cascade in the muscle

- Treatment that targets peripheral structures



Mgmt of Neuro-musculoskeletal Pain and Sensitization





Modulation of the dysfunctional, hyperexcitable dorsal horn neurons tha cause allodynia, hyperalgesia and expanded pain referral patterns

- Treatment that desensitizes the dorsal horn of the spinal cord

Mgmt of Neuro-musculoskeletal Pain and Sensitization

Correction of fear avoidance behaviors, catastrophizing, and depression

- Treatments such as behavioral management, relaxation, coping skills, cognitive retraining, etc.

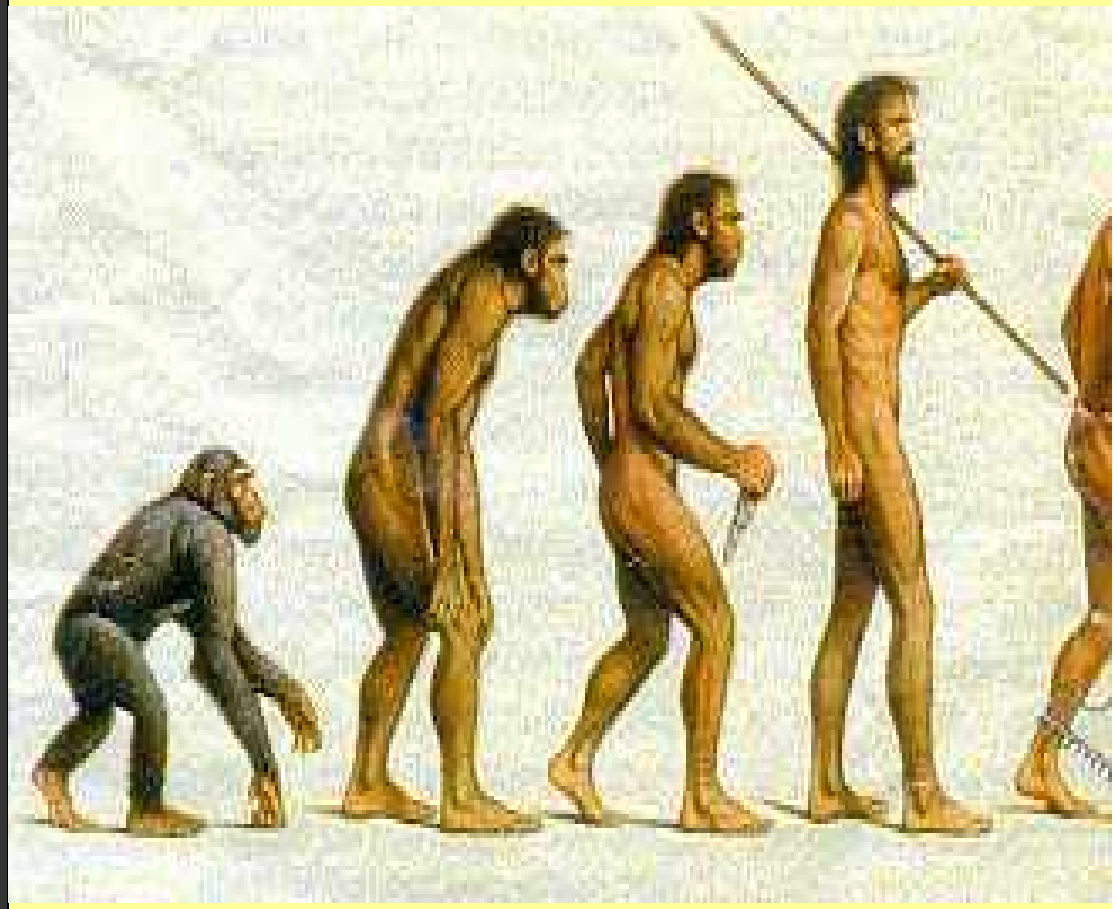
Address Perpetuating Factors

- Poor Body Mechanics
- Poor Posture

Forward Head Posture

Hans-Werner
Weisskircher
www.trigger-point.com

Progress?



Forward Head Posture

Post Treatment Flexibility Exercises

Aerobic Conditioning

Self Massage Techniques

Arigato!

Efharisto!

Gamsahabnida!

Grazie!

Obrigado!

Thank You!

Tak, Takk,Tack!

Dekuju!

THANK YOU!

Spasiba!

Xie Xie!

Merci!

Chok-ran!

Dhanyavaad!

Hvala!

Cam On!

Khop Khun Mak Kha!

Shokriya!

Toda!

Muchisimas

Mamnun!

Gracias!