Osteopathy Congress 2023: Joints and Manipulation

From Joints to the Central Nervous System

Berlin, Germany

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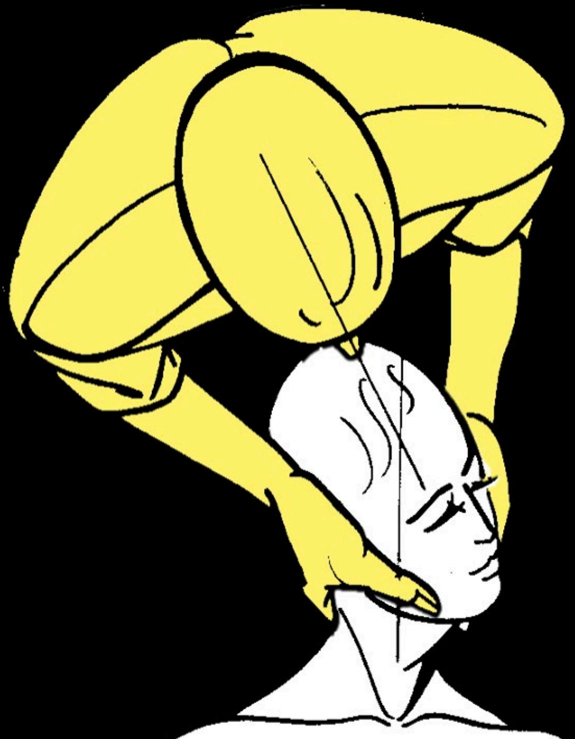
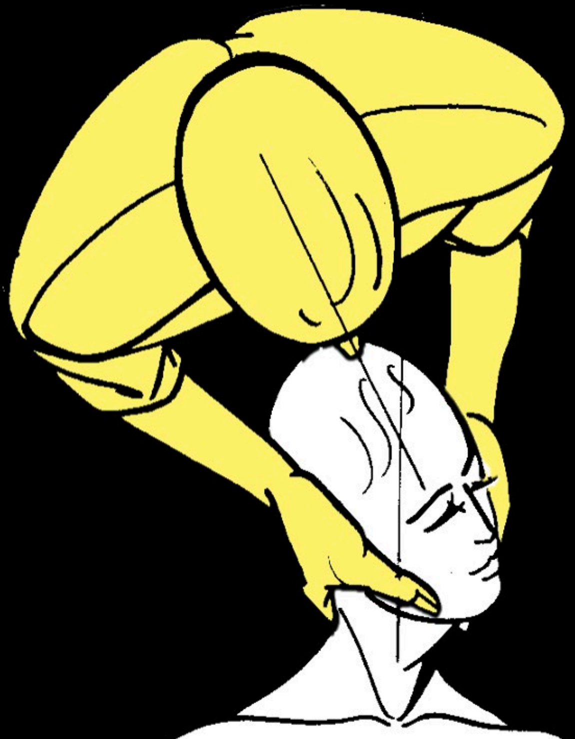
Background



- Pain is the most common presentation in clinical osteopathic practice
- Osteopaths and osteopathic physicians uses a variety of passive and active procedures for pain alleviation and management
- In the early part of the profession there was a strong tissue-based orientation for understanding the effects of osteopathic care
- In the last two decades a more neurocentric orientation for the effects have emerged

Learning Objective of Presentation

To highlight descending modulation of nociception following the use of joint mobilization and manipulation



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- Osteopaths and osteopathic physicians uses a variety of passive and active procedures for pain alleviation and management
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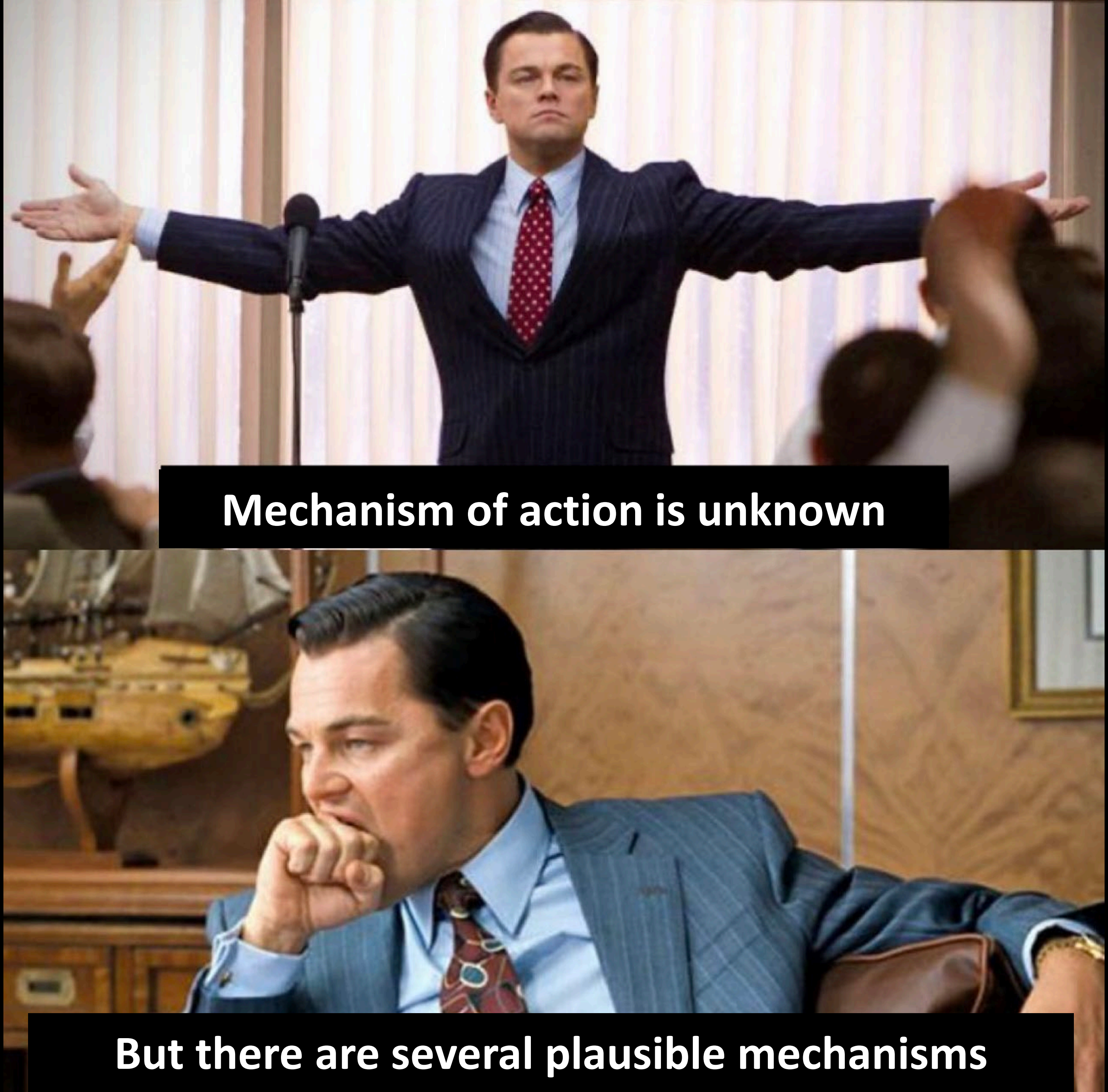
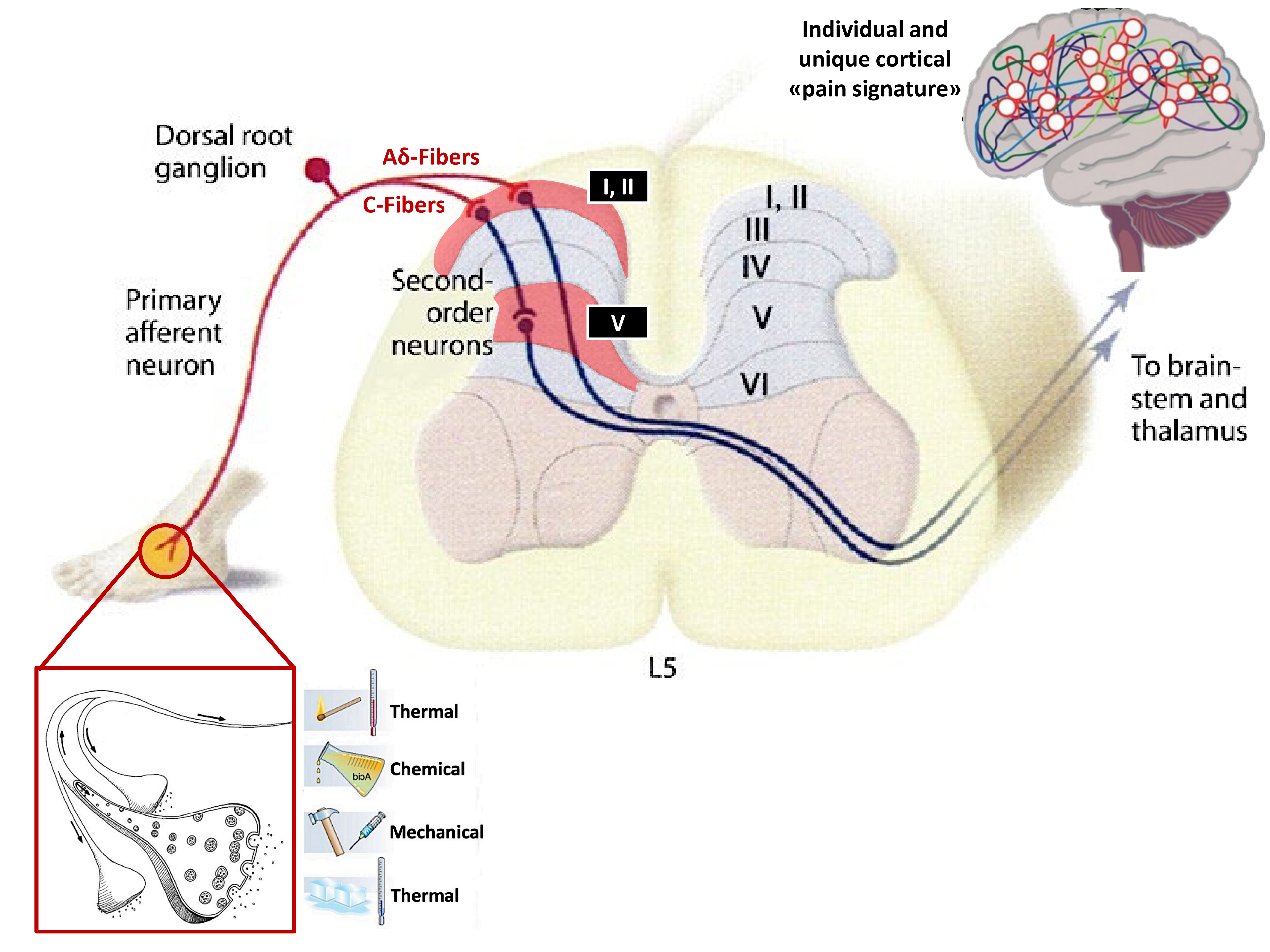
- Navigating the landscape of pain in patients is a long and winding road
- A biopsychosocial and enactive perspective underpins the principles of person-centered care
- Osteopathy sits well within these clinical frameworks

"Pain is the result of a conflict between stimuli and the individual as whole"

Canguilhem 1970

Mechanism of action is unknown


Mechanism of action is unknown
But there are several plausible mechanisms



Individual and unique cortical «pain signature»
Dorsal root ganglion
Aδ-Fibers
C-Fibers
I, II
Second-order neurons
V
Primary afferent neuron
I, II
III
IV
V
VI
To brain-stem and thalamus
L5
Thermal
Chemical
Acid
Mechanical
Thermal

Levels with Nociceptive and Pain Modulation

1

Nociceptiv Signaltransmission

- Stimulation TSP
- Altered biochemical environment around thenociceptors
- Attenuation nocifensive reflexes: muscle tone

Osteopathic Manipulative Technique

3

Pain Experience

- CBT
- ACT
- CFT
- NPE

Descending Pain Inhibition

- Inhibition of nociceptive signal transmission through descending serotonergic and noradrenergic pathways on the dorsal horn
- OMT
- Affective Touch
- Communication

1
2

1 Peripheral Sensitization

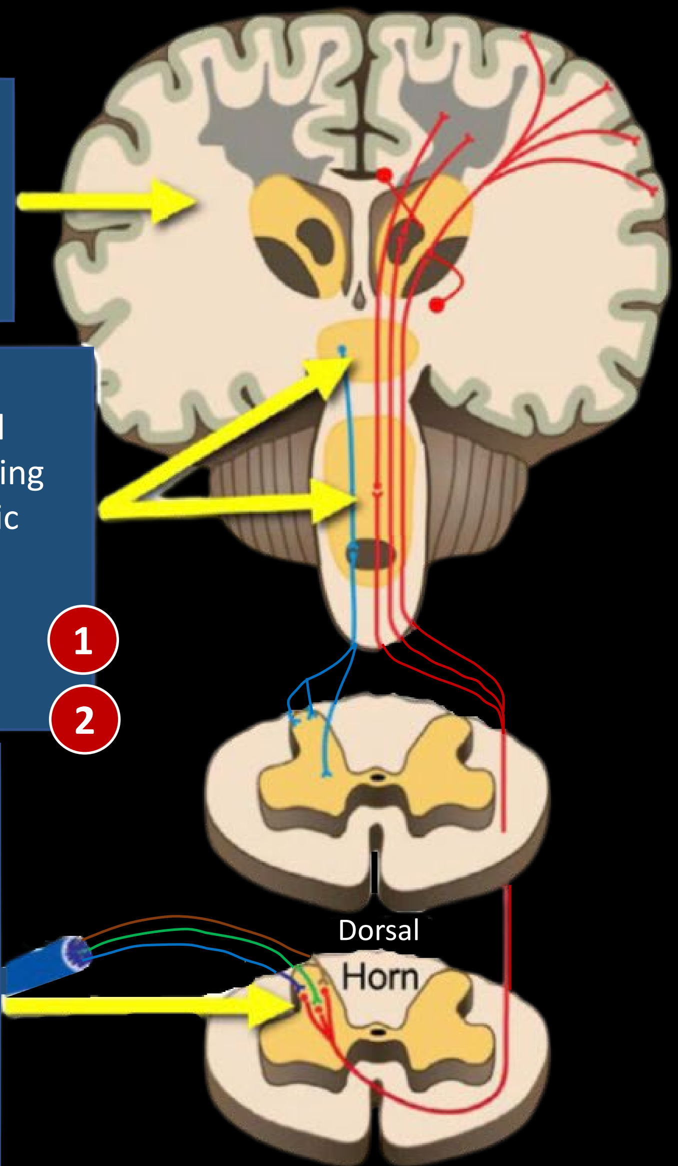
2 Central Sensitization

3 Cognitive Sensitization

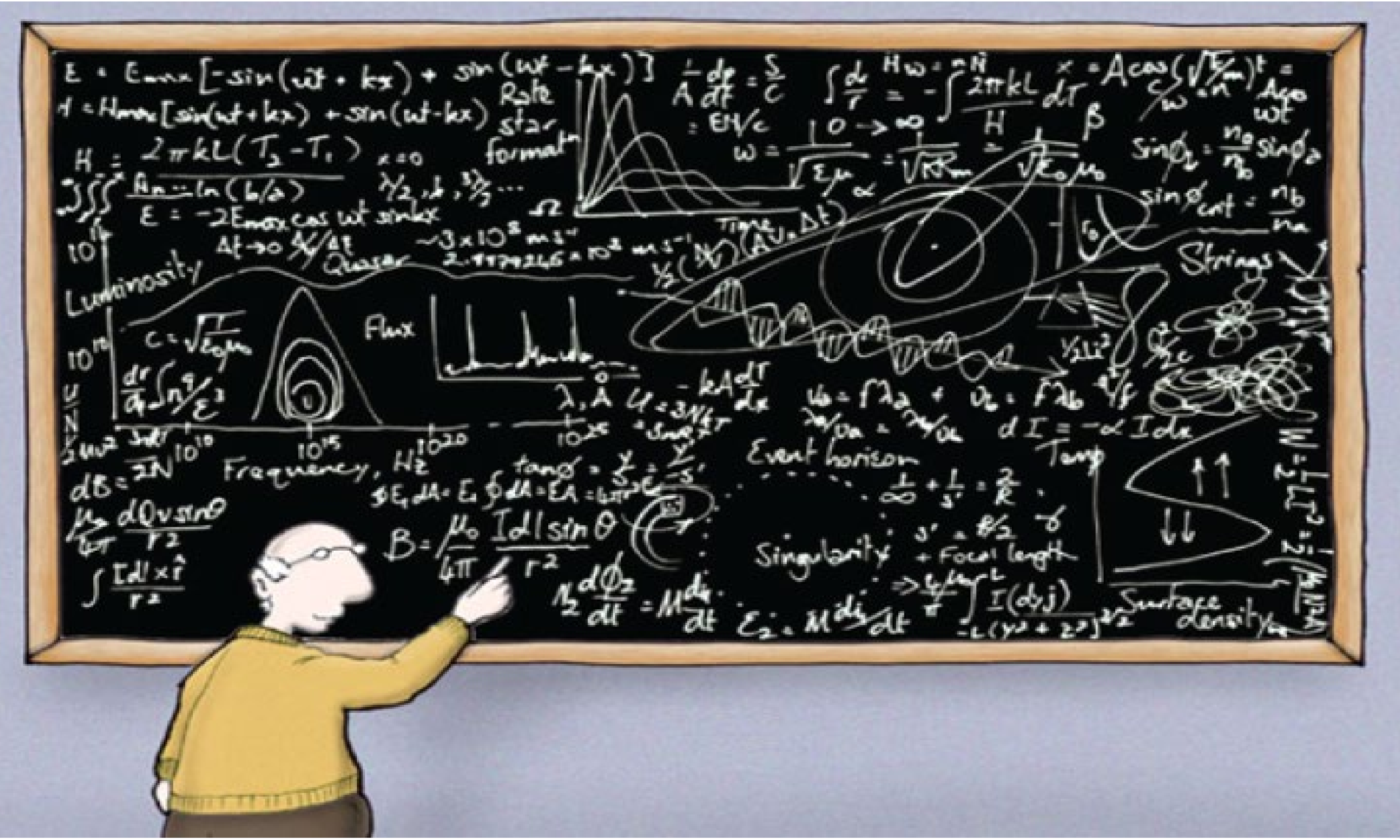
Long-Term Potentiation (LTP)

- Attenuated central sensitization through redcued sensory input from primary afferent nerves (PAN) and activation of DPIS

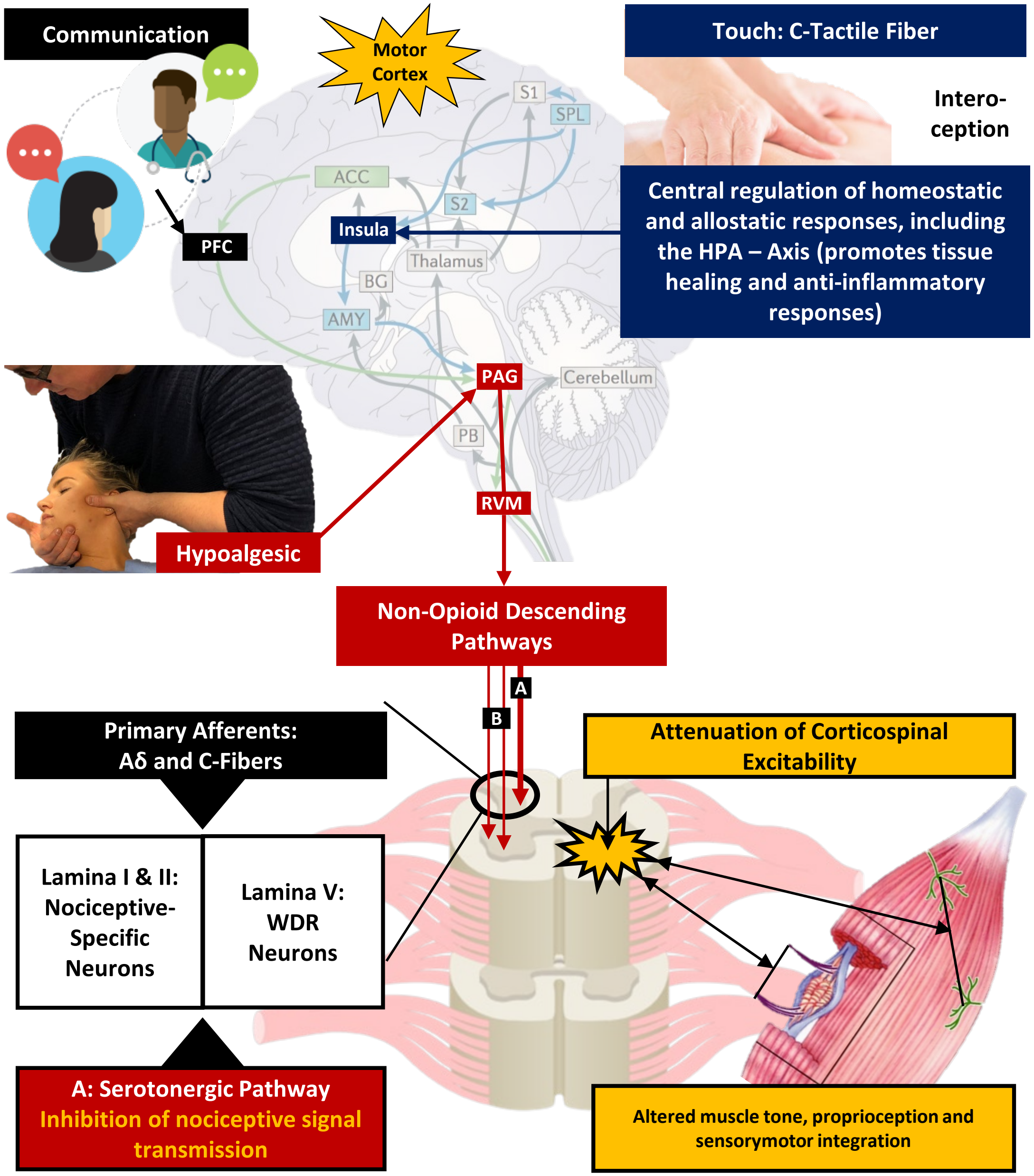
2



Fossum (2022)



OMT is a Complex Intervention

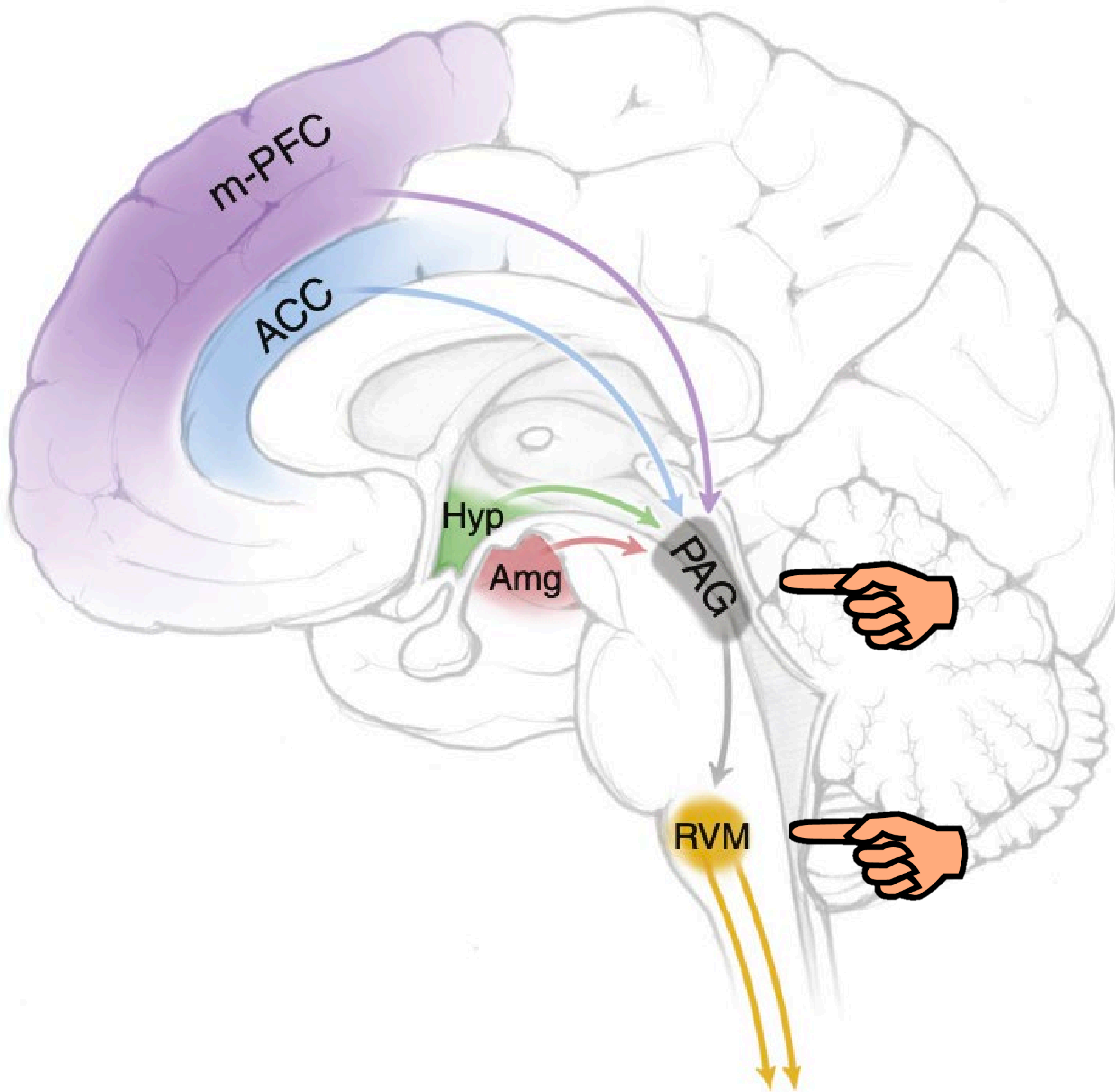


- The proposed hypoalgesic, neuromuscular, autonomic and neuroendocrine effects centers around the activation of the central nervous system
  - Activation of the descending pain inhibitory systems (DPIS) from the grey periaqueductal region (PAG) to the dorsal horn of the spinal cord
  - Attenuation of corticospinal excitability
  - Improved interoception: body-image, self-awareness and physiological negative feedback loops for autonomic and neuro-endocrine immune regulation
- Possible stress regulation through the combined effects of manual treatment, touch and communication

OMT is a Complex Intervention

Fryer and Fossum (2009); Fryer et al (2013); Bauer (2018); Gyer et al (2019); Ceritelli et al (2020); Gyers-Montoro et al (2022)

Winn, H.R. (Ed)., *Youmans and Winn Neurological Surgery, 8th Ed.*, Elsevier Saunders, Philadelphia, 2022



Pain-modulating networks with links to the periaqueductal grey region (PAG) and the rostral ventromedial medulla (RVM):

Cognition, affective and emotional behaviour will have an effect on the descending pain inhibitory systems (DPIS)

OMT is a Complex Intervention

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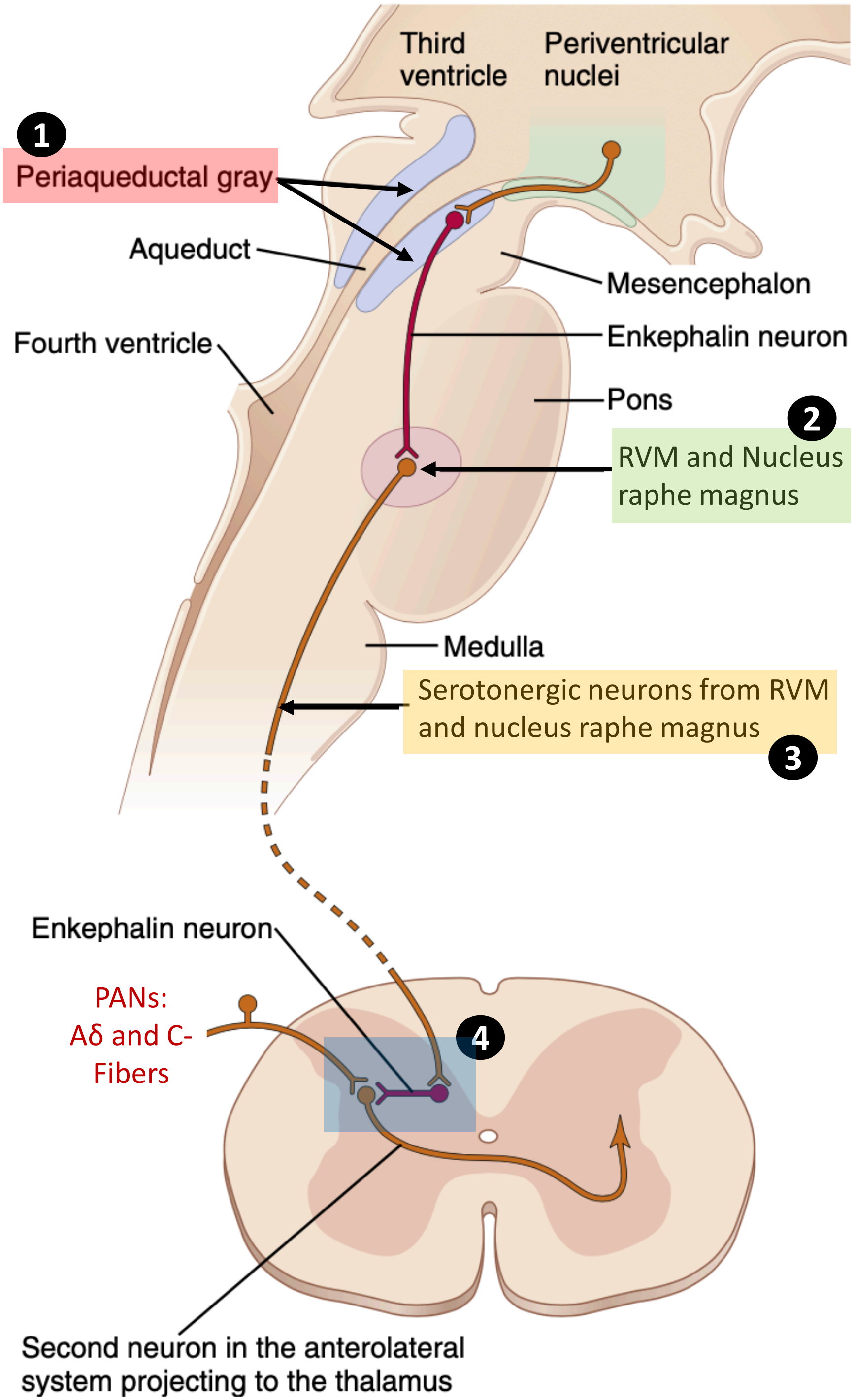


The brain has the capability of supressing input of nociceptive signals to the nervous system:

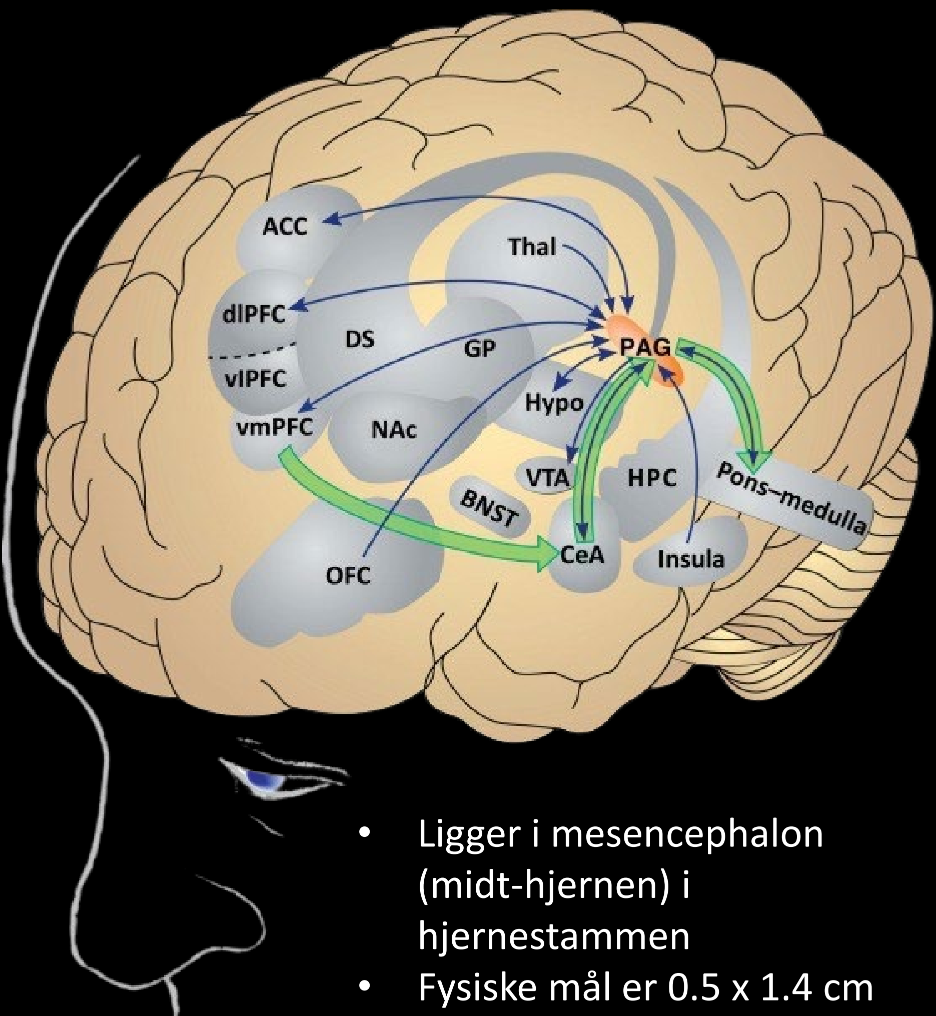
Descending Pain Inhibitory System

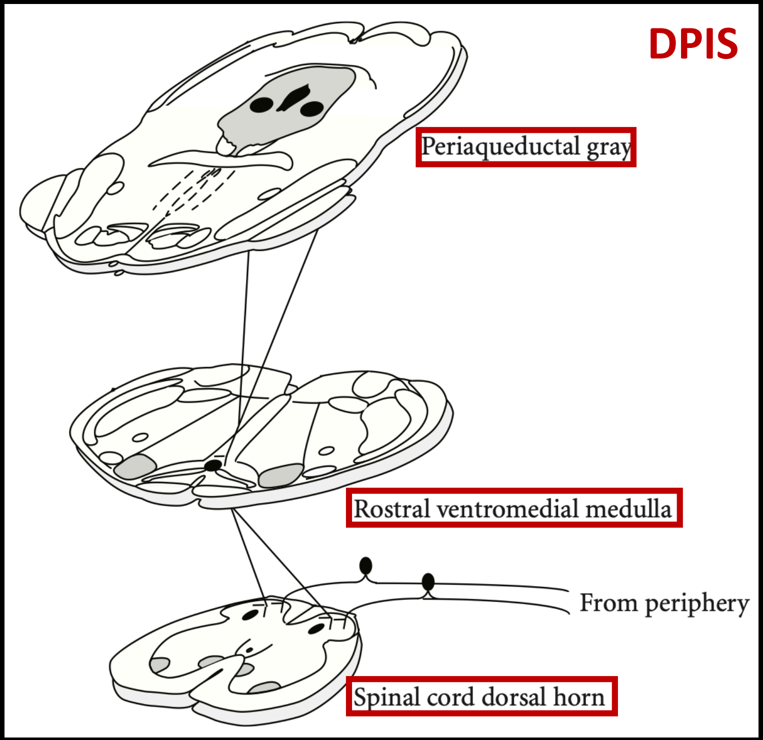
The DPIS has several major components

1. **The periaqueductal grey (PAG):** Neurons in this region sends signals to
2. **The rostroventromedial medulla** (RVM) and its **nucleus raphe magnus**: From these second order signals are transmitted down
3. **The dorsolateral columns in the spinal cord**
4. A nociceptive inhibitory complex located in the **dorsal horn of the spinal cord**

George et al (2019); Yoshimura et al (2006)

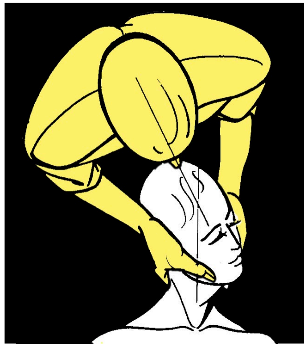
The Periaqueductal Grey (PAG)



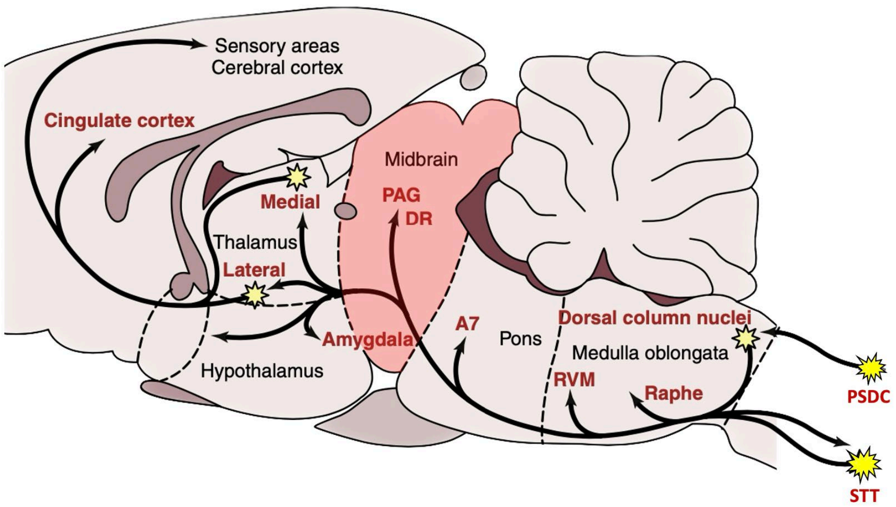


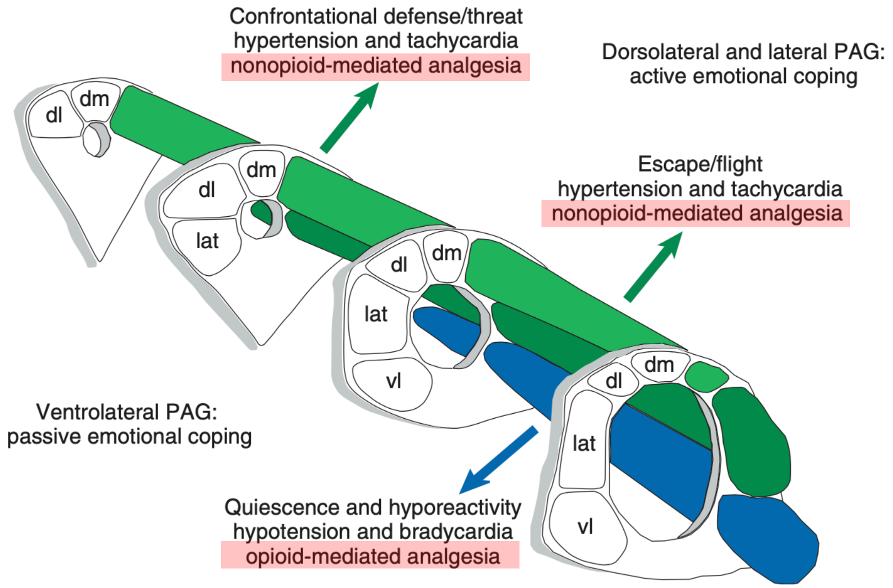
- Ligger i mesencephalon (midt-hjernen) i hjernestammen
- Fysiske mål er 0.5 x 1.4 cm
- Har gjensidige forbindelser med PFC, insula, hypothalamus, hippocampus, amygdala og ryggmargen

- Integrerer emosjoner med det autonome, nevroendokrine og immun systemet for a fasilitere responser på trusler
- Spiller en viktig rolle ved stimuli som er negative forsterkere og som trigger autonom aktivering, hypoalgesi og adferds responser



The Players:
The Periaqueductal Grey Region (PAG)





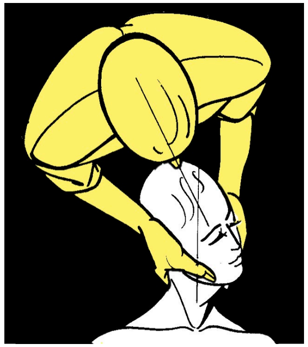
Question:

How does joint mobilization and manipulation activate the PAG for hypoalgesic effects?

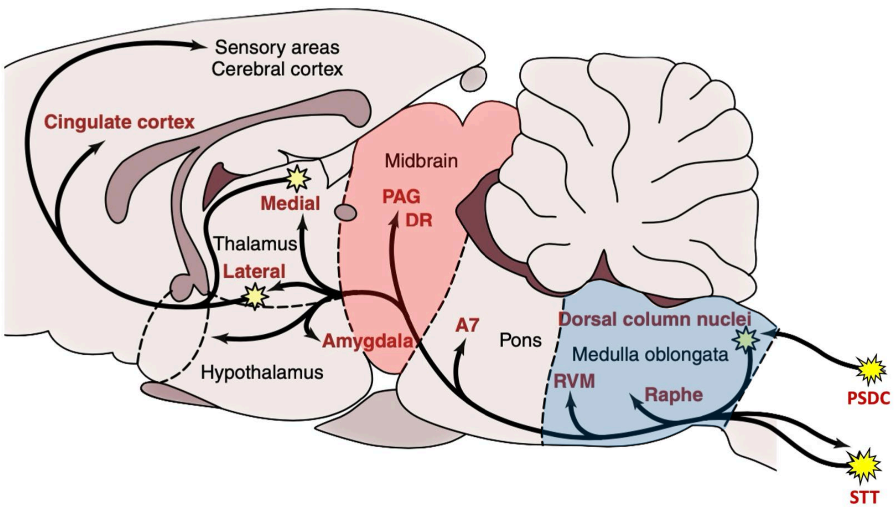
This is not fully known

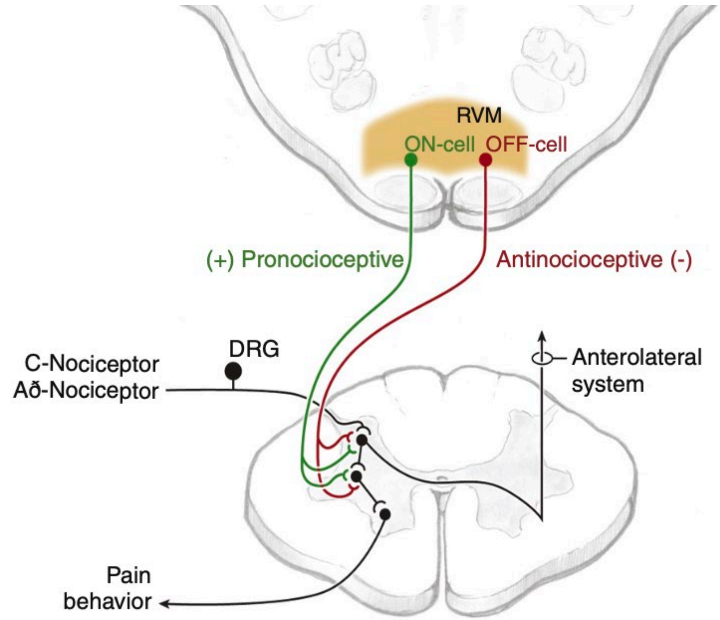
- Technique as counter-irritation: activation of PAG
- Normalization of negative feedback-loops removing inhibition of anti-nociception from PAG / RVM
- Stress-induced analgesia

Basbaum et al (2008); Benzon et al (2014); Winn et al (2022)



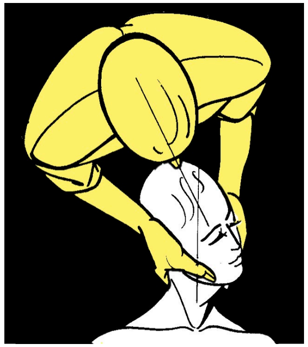
The Players:
Rostral Ventromedial Medulla (RVM)



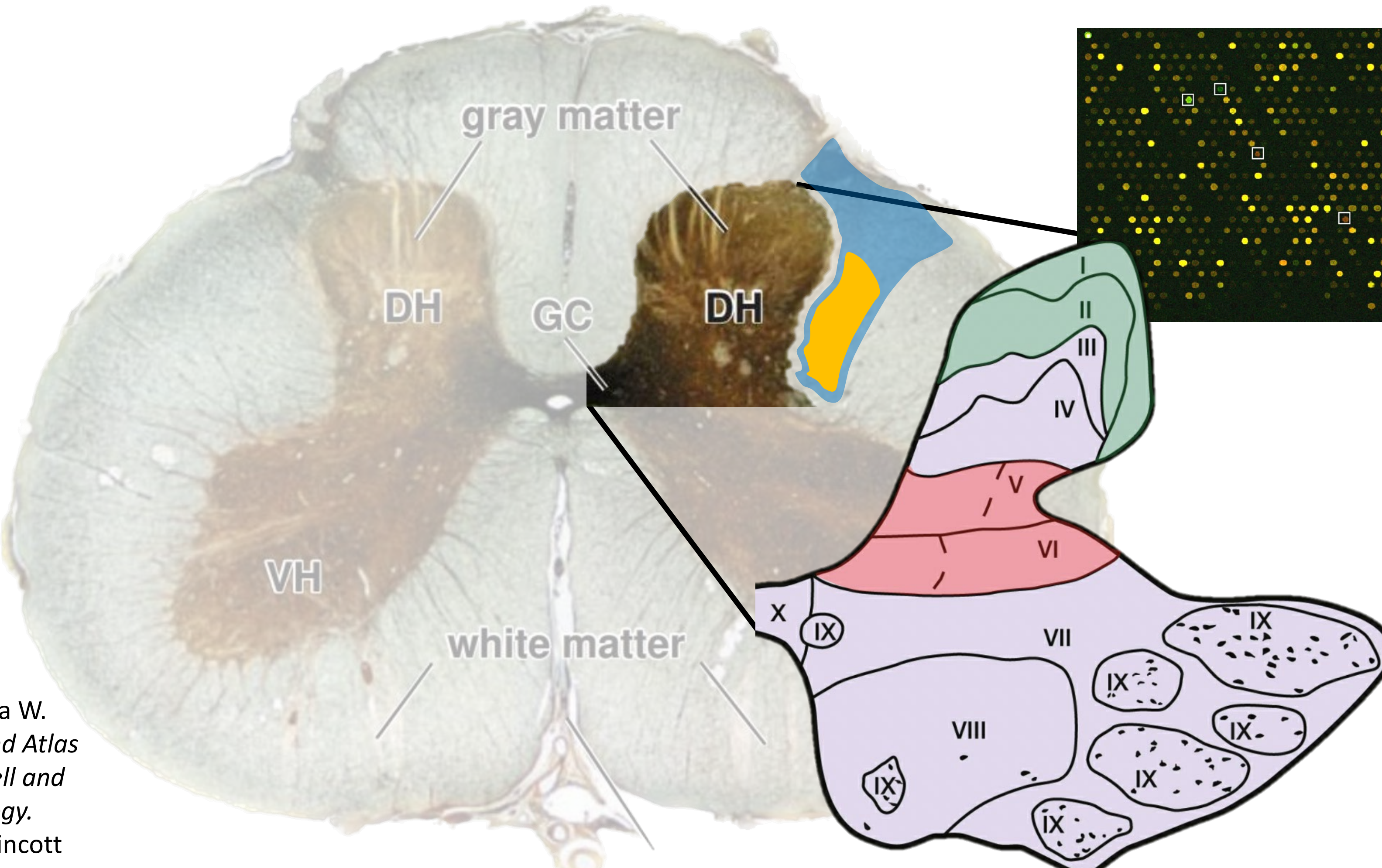


- Anatomically the RVM is not only centered in the nucleus raphe magnus but also includes adjacent ventromedial reticular formation (for feedback-loops)
- Receives top-down (higher centers) and bottom-up (nociception) input
- The RVM modulates nociceptive signal transmission: **Pronociceptive** and **Antinociceptive**

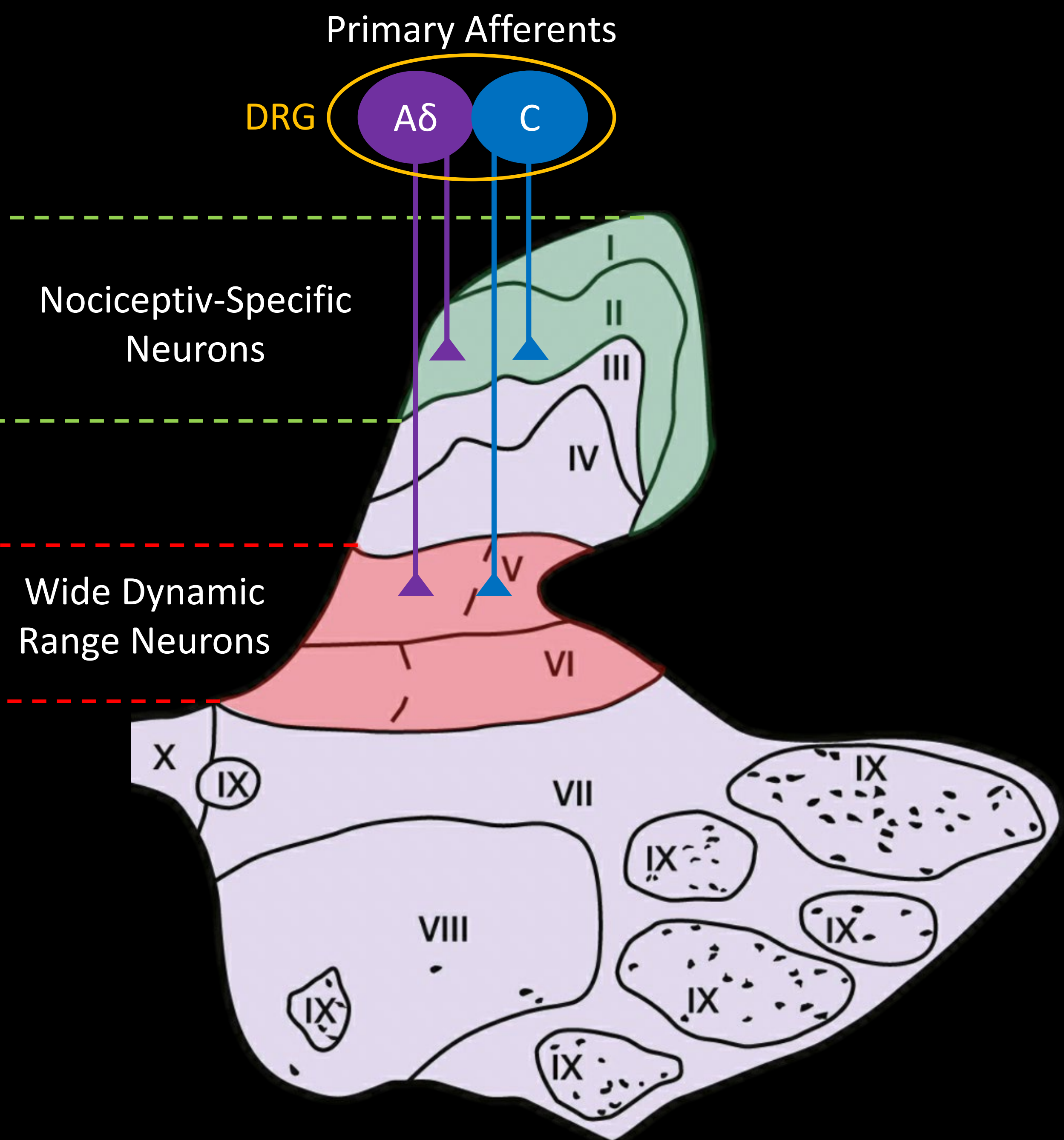
Benzon et al (2014); Chen et al (2022); Winn et al (2022)



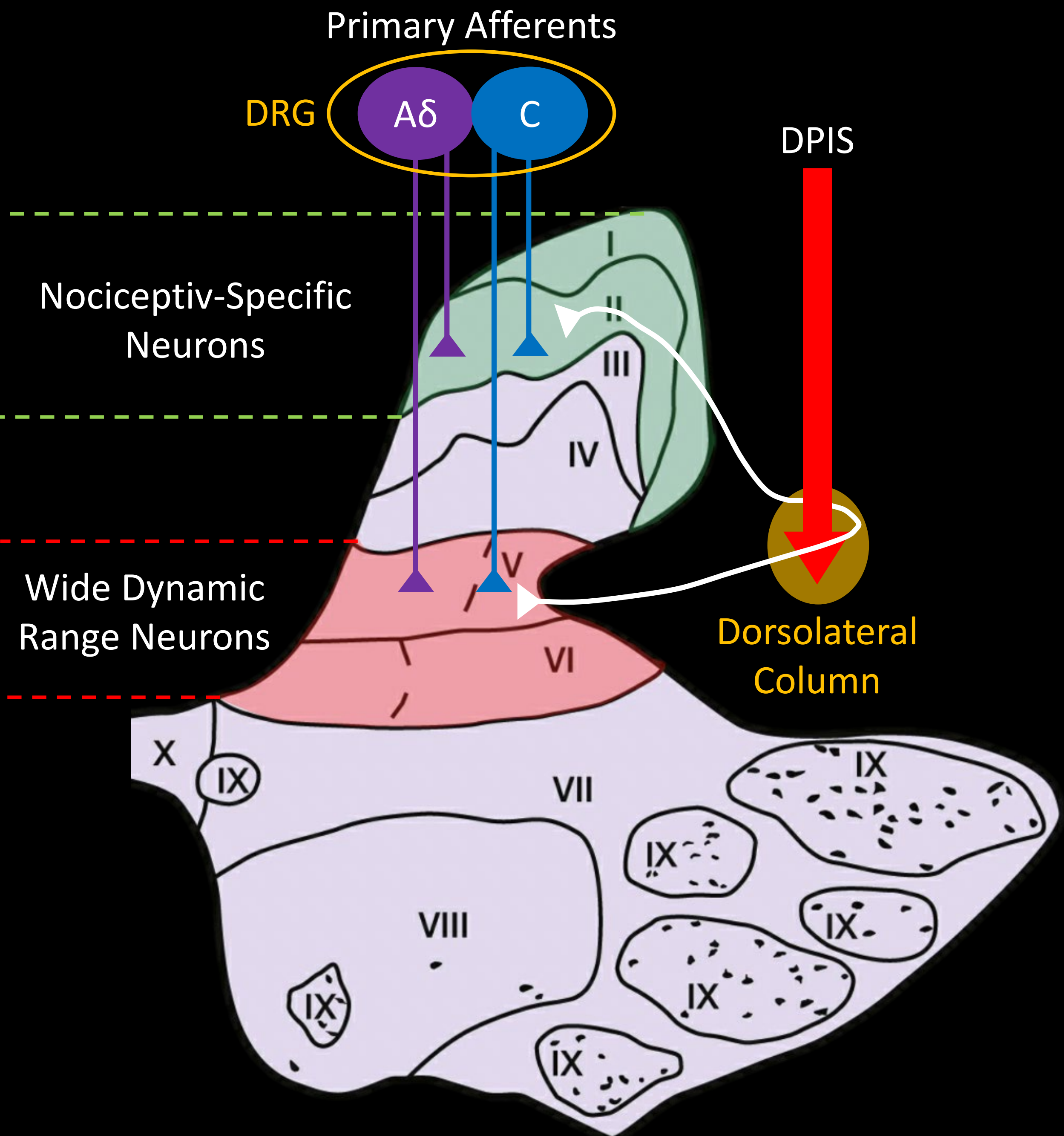
The Playerground: Dorsal Horn of the Spinal Cord



Ross MH, Pawlina W. *Histology: A Text and Atlas with Correlated Cell and Molecular Biology.* Philadelphia: Lippincott Williams & Wilkins 2021: 403



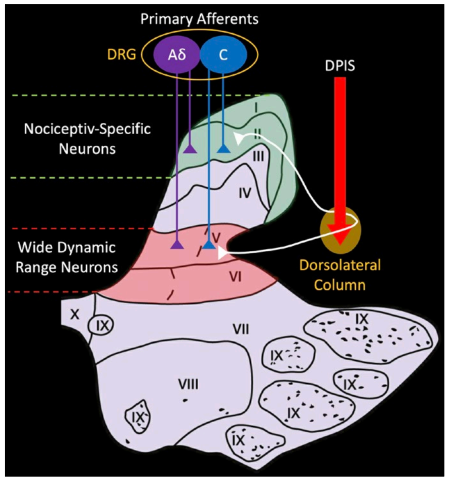
Primary Afferents
DRG
Aδ
C
Nociceptiv-Specific Neurons
Wide Dynamic Range Neurons
I
II
III
IV
V
VI
VII
VIII
IX
X



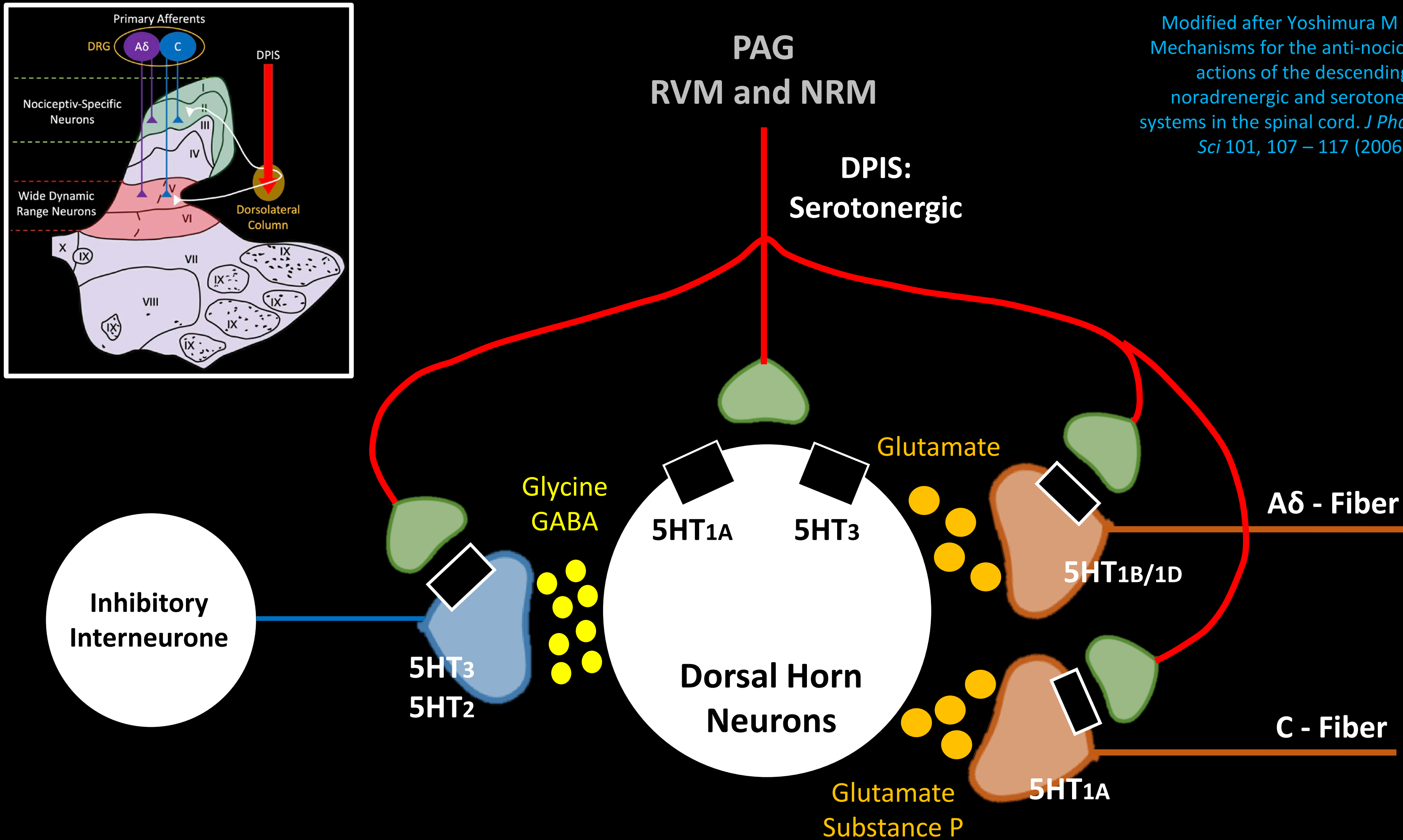
- The DPIS uses primarily serotonergic pathways from the
  - PAG
  - RVM and NRM
- In the spinal cord three families of receptors are present
  - 5HT1, 5HT2, 5HT3
- They are involved in the inhibition of the noci-ceptive processes

It has been proposed that the largest subpopulation of serotonergic neurons are 5HT1A:

These are involved in the hypoalgesia from joint manipulation and mobilisation



Primary Afferents
DRG
Aδ
C
DPIS
Nociceptiv-Specific Neurons
Wide Dynamic Range Neurons
Dorsolateral Column
I
II
III
IV
V
VI
VII
VIII
IX
X

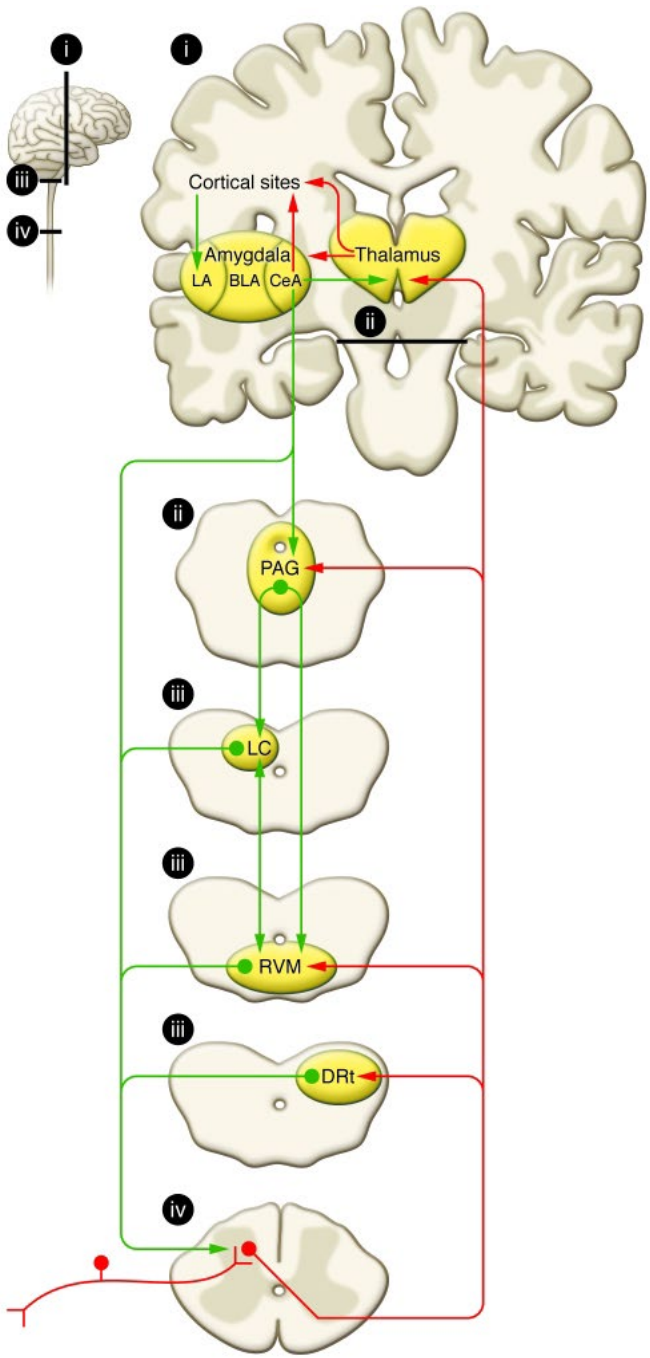


Modified after Yoshimura M et al. Mechanisms for the anti-nociceptive actions of the descending noradrenergic and serotonergic systems in the spinal cord. *J Pharmacol Sci* 101, 107 – 117 (2006)

The terminal endings of serotonergic fibers seems to be dendritic (non-synaptic) with volume-release transmission widely affecting the vicinity of their release site

Yoshimura M et al. Mechanisms for the anti-nociceptive actions of the descending noradrenergic and serotonergic systems in the spinal cord. *J Pharmacol Sci* 101, 107 – 117 (2006)

Perrin FE et al. Anatomical study of serotonergic innervation and 5-HT_{1A} receptor in the human spinal cord. *Cell Death and Disease* (2011); 2; e218



Noradrenergic Inhibition

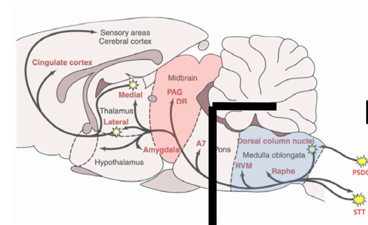
- Most of the presentation has focused on the role of the PAG and RVM and the serotonergic pathways in antinociception
- This inhibition may largely be mediated by 5-HT_1 and $_2$ receptors and possibly indirectly by 5-HT_3-mediated excitation of GABAergic inhibitory interneurons

Data suggests that knee joint manipulation activates descending inhibitory pathways that utilize serotonin and **noradrenaline**, which inhibit transmission of nociceptive information by acting on 5-HT_{1A} and **alpha2-adrenergic receptors** in spinal cord of rats

Skyba DA et al. Joint manipulation reduces hyperalgesia by activation of monoamine receptors but not opioid or GABA receptors in the spinal cord. *Pain* 106 (2003) 159 - 169

Joint Mobilization and Manipulation:
Biological Multifactorial Model for Hypoalgesic Effects

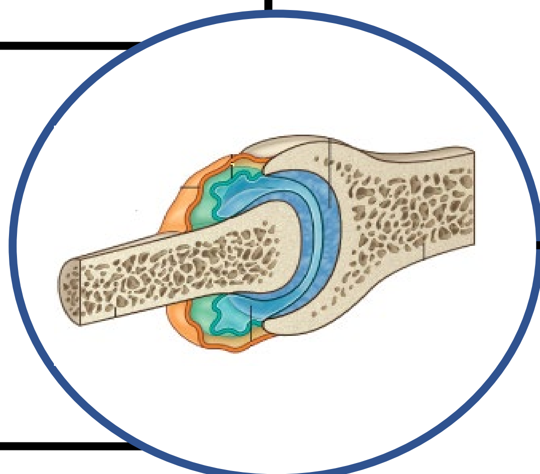
PERIPHERAL | **CENTRAL**

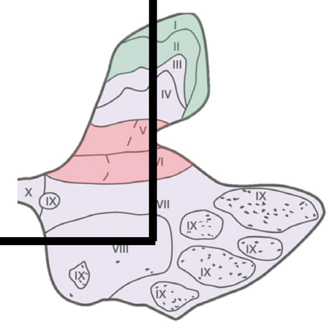


Activation of the Descending Pain Inhibitory System (DPIS)

Assist Tissue Repair and Healing

Mechanical Effects on Connective Tissues



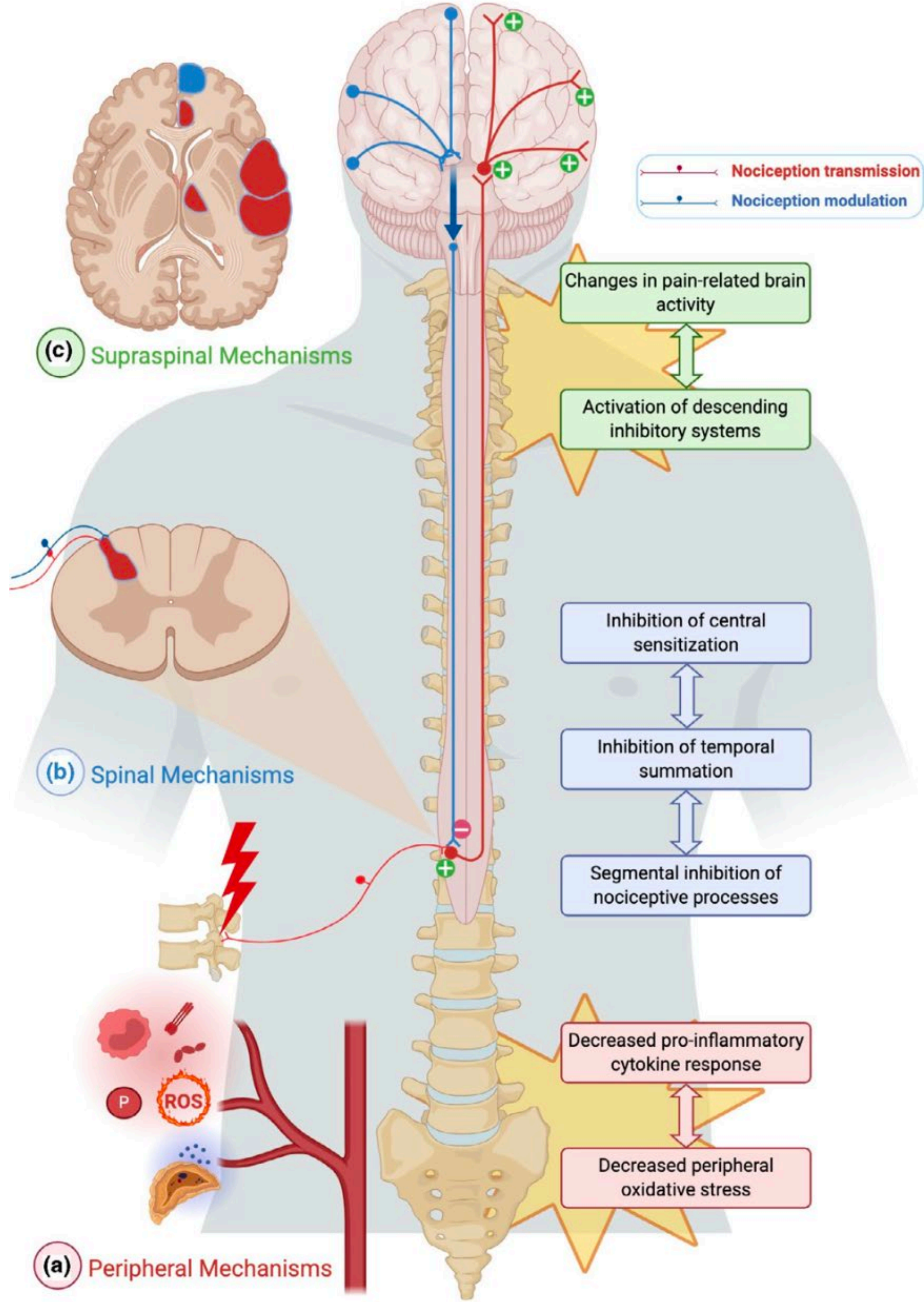


Activation of Segmentally Inhibitory Mechanisms

Alterations in the Intra-Articular Environment (TSP)

Alterations in the Biochemical Environment of Nociceptors

Fossum (2012, 2015)



Pain mechanisms likely to be influenced by spinal manipulation

Supraspinal mechanisms

- Changes in central networks involved in pain processing
- Activation of descending pain inhibitory systems (DPIS)

Spinal mechanisms

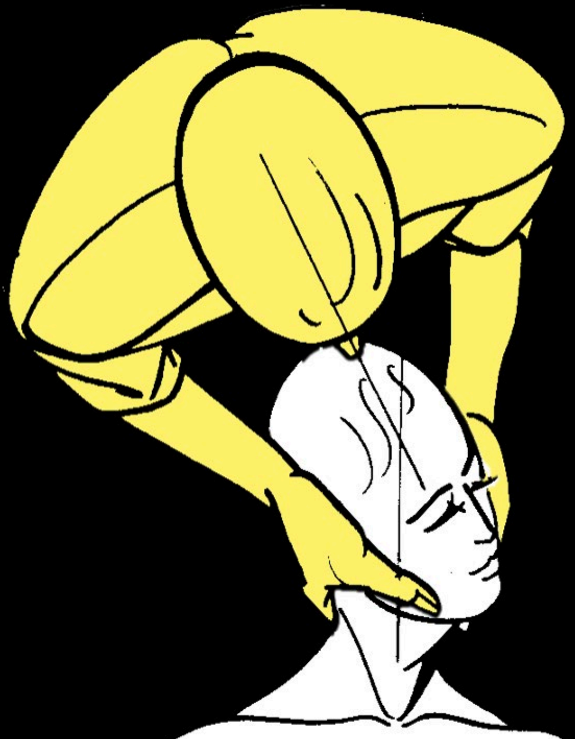
- Inhibition of central sensitization
- Inhibition of temporal summation and LTP
- Inhibition of nociceptive signal transmission

Peripheral mechanisms

- Decrease pro-inflammatory cytokine response and improve biochemical environment around nociceptors

Gevers-Montoro et al 2022

Concluding Remarks



- RCTs, Systematic Reviews and Clinical Guidelines indicates that osteopathic manipulative treatment is a rational and effective choice of care in musculoskeletal pain
- The pain alleviating effects of such treatments seems to center on the effects of activation of the central nervous system and the descending pain inhibitory systems
- Much research is still needed to explore these mechanisms and to elucidate the long-term effects