

# L'ostéopathie médicale, c'est de la neurophysiologie !

**David GASQ – 2 octobre 2021**

*Médecine Physique et Réadaptation*

*Maitre de Conférence Universitaire – Praticien Hospitalier, Université Toulouse 3,  
CHU de Toulouse*



# Comment ça marche ?

2 / 37

Contexte

Segmentaire

SNA

Supra-spinal

Synthèse

## Neurophysiology of human touch and eye gaze in therapeutic relationships and healing: a scoping review

Fiona Kerr<sup>1,3,4,5</sup>, Rick Wiechula<sup>1,2</sup>, Rebecca Feo<sup>1,2</sup>, Tim Schultz<sup>1,2</sup>, Alison Kitson<sup>1,2</sup>

*JBI Database System Rev Implement Rep* 2019; 17(2):209–247.

Journal of Manipulative and Physiological Therapeutics  
Volume 24, Number 1, January 2001  
0898-0101/2001/25/01-00-00

### ORIGINAL ARTICLES



Response of Muscle Proprioceptors to Spinal Manipulative-like Loads in the Anesthetized Cat  
Joel G. Pickar, DC, PhD,\* and John D. Wheeler, DC\*

Received 10 December 2020 | Received 1 March 2021 | Accepted 27 March 2021  
DOI: 10.1096/j.jmpt.2021.03.001

### REVIEW ARTICLE

## Neurophysiological mechanisms of chiropractic spinal manipulation for spine pain

Carlos Gevers-Montano<sup>1,2,3</sup> | Benjamin Provencier<sup>1,2</sup> | Martin Descarreaux<sup>1,4</sup> |  
Aurimas Ortega de Mues<sup>1</sup> | Mathieu Piche<sup>2,5</sup>

*Spine (Phila Pa 1976)*. 1999 Jan 15;24(2):146-52; discussion 153.  
doi: 10.1097/00007632-199901150-00012.

## Electromyographic responses of back and limb muscles associated with spinal manipulative therapy

W Herzog<sup>1</sup>, D Scheele, P J Conway

*European Journal of Applied Physiology* (2021) 121:2675–2730  
<https://doi.org/10.1007/s00401-021-04922-8>

### INVITED REVIEW

## The contemporary model of vertebral column joint dysfunction and impact of high-velocity, low-amplitude controlled vertebral thrusts on neuromuscular function

Heidi Haavik<sup>1</sup>, Nitika Kaman<sup>1,2</sup>, Kelly Holt<sup>1</sup>, Imran Khan Niazi<sup>1,2,3,4,5</sup>, Imran Amjad<sup>1,4</sup>, Amit N. Pujas<sup>1,4</sup>,  
Kamal Siki Turker<sup>1,4</sup>, Bernadette Murphy<sup>6</sup>



### LITERATURE REVIEW

## Mechanism of Action of Spinal Mobilizations

A Systematic Review

Ion Lascuran-Aguirrebeña, MSc,<sup>1</sup> Di Newham, PhD,<sup>1</sup> and Duncan John Critchley, PhD<sup>1</sup>

*Spine* Volume 41, Number 2, pp 159–172  
© 2016 Wolters Kluwer Health, Inc. All rights reserved.

*Man Ther.* 2009 October ; 14(5): 531–538. doi:10.1016/j.mait.2008.09.001.

## The Mechanisms of Manual Therapy in the Treatment of Musculoskeletal Pain: A Comprehensive Model

Joel E Bialosky, PT, MS<sup>1</sup>, Mark D Bishop, PT, PhD<sup>1</sup>, Don D Price, PhD<sup>2</sup>, Michael E Robinson, PhD<sup>3</sup>, and Steven Z George, PT, PhD<sup>1</sup>

*Journal of Chiropractic & Manual Therapy* (2019) 27:60  
<https://doi.org/10.1188/jcmpt.2019.27.02.05>

### SYSTEMATIC REVIEW

## Unravelling functional neurology: does spinal manipulation have an effect on the brain? - a systematic literature review

Anne-Laure Meyer<sup>1,2,3</sup>, Michel-Ange Arcomin<sup>1,2</sup>, Martin Schubert<sup>1</sup>, Petra Schweinhardt<sup>1</sup> and  
Gefl. 2011 December 23; 147(7): 1615–1627. doi:10.1016/j.cecell.2011.11.027.

## The functional organization of cutaneous low-threshold mechanosensory neurons

Lishi Li<sup>1,\*</sup>, Michael Rutlin<sup>1,\*</sup>, Victoria E. Abratra<sup>1</sup>, Colleen Cassidy<sup>2</sup>, Laura Kus<sup>3</sup>, Shiaoqing Gong<sup>3</sup>, Michael P. Jankowski<sup>1</sup>, Wengjn Luo<sup>1,2</sup>, Nathaniel Heintz<sup>1</sup>, H. Richard Koerber<sup>1</sup>, C. Jeffery Woodbury<sup>1</sup>, and David D. Ginty<sup>1</sup>



Manual Therapy  
Volume 24, August 2016, Pages 67–74

Manuscript

Enhance placebo, avoid nocebo: How contextual factors affect physiotherapy outcomes

Maria Tzika, A.R., Giacomo Recanatini

*Journal of Integrative Medicine* 17 (2015) 108–117

Contents lists available at ScienceDirect

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Review

Spinal manipulation therapy: Is it all about the brain? A current review of the neurophysiological effects of manipulation  
Giles Cyper<sup>1,\*</sup>, Jimmy Michael<sup>1</sup>, James Inkleberger<sup>1</sup>, Jaya Shanker Tedia<sup>1</sup>

<sup>1</sup>The London College of Chiropractic, London, UK; <sup>2</sup>York Hired Druggist

<sup>3</sup>Department of Biology, Middlebury College, Middlebury, Vermont, USA; <sup>4</sup>Department of Biology, Middlebury College, Middlebury, Vermont, USA; <sup>5</sup>Department of Biology, Middlebury College, Middlebury, Vermont, USA

- Aspects biomécaniques & neurophysiologiques
- Action locale et à distance
  - Explications segmentaires et supra-segmentaires
- Actions spécifiques et non-spécifiques

## Techniques variées

- HVLA – LVHA
- Myotensif
- Jones
- Décordage
- ...

# Bases neurophysiologiques de l'effet des TM

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["Neurophysiology"[Mesh]] AND "Musculoskeletal Manipulations"[Mesh] Search

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ARTICLE ATTRIBUTE

Associated data

ARTICLE TYPE

Books and Documents

Clinical Trial

Meta-Analysis

Randomized Controlled Trial

Review

Systematic Review

PUBLICATION DATE

1 year

5 years

10 years

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SPECIES

Humans

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- Neurophysiological Effects of High Velocity and Low Amplitude Spinal Manipulation in Symptomatic and Asymptomatic Humans: A Systematic Literature Review.

Wirth B, Gassner A, de Bruin ED, Axén I, Swanenburg J, Humphreys BK, Schweinhardt P. *Spine (Phila Pa 1976)*. 2019 Aug 1;44(15):E914-E926. doi: 10.1097/BRS.0000000000003013. PMID: 31335790
- Neurophysiology of human touch and eye gaze in therapeutic relationships and healing: a scoping review.

Kerr F, Wlechula R, Feo R, Schultz T, Kitson A. *JBI Database System Rev Implement Rep*. 2019 Feb;17(2):209-247. doi: 10.11124/JBISRR-2017-003549. PMID: 30730854 **Free PMC article.** Review.
- The biology of manual therapies.

Clark BC, Thomas JS, Walkowski SA, Howell JN. *J Am Osteopath Assoc*. 2012 Sep;112(9):617-29. PMID: 22984235 Review.
- From acute musculoskeletal pain to chronic widespread pain and fibromyalgia: application of pain neurophysiology in manual therapy practice.

Nijs J, Van Houdenhove B. *Man Ther*. 2009 Feb;14(1):3-12. doi: 10.1016/j.math.2008.03.001. Epub 2008 Jun 3. PMID: 18511329 Review.
- Neurophysiological effects of spinal manipulation.

Pickar JG. *Spine J*. 2002 Sep-Oct;2(5):357-71. doi: 10.1016/s1529-9430(02)00400-x. PMID: 14589467 Review.
- Response of muscle proprioceptors to spinal manipulative-like loads in the anesthetized cat.

Pickar JG, Wheeler JD. *J Manipulative Physiol Ther*. 2001 Jan;24(1):2-11. doi: 10.1067/jmmt.2001.112017. PMID: 11174689
- Neurophysiologic research and clinical practice.

Bailey HW. *J Am Osteopath Assoc*. 1975 Jul;74(11):1037-51. PMID: 1043888 No abstract available.

PubMed.gov

Neurophysiolog\* AND "Musculoskeletal Manipulations"[Mesh] Search

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RESULTS BY YEAR

Filters applied: Review, Systematic Review. Clear all

TEXT AVAILABILITY

Abstract

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ARTICLE ATTRIBUTE

Associated data

ARTICLE TYPE

Books and Documents

Clinical Trial

Meta-Analysis

Randomized Controlled Trial

Review

Systematic Review

- Neurophysiological mechanisms of chiropractic spinal manipulation for spine pain.

Cite Gevers-Montoro C, Provencher B, Descarreaux M, Ortega de Mues A, Piché M. *Eur J Pain*. 2021 Aug;25(7):1429-1448. doi: 10.1002/ejp.1773. Epub 2021 Apr 15. PMID: 33786932 Review.
- Chiropractic care for hypertension: Review of the literature and study of biological and genetic bases.

Cite Sullivan SG, Paolacci S, Kiani AK, Bertelli M. *Acta Biomed*. 2020 Nov 9;91(13-S):e2020017. doi: 10.23750/abm.v91i13-S.10524. PMID: 33170172 **Free PMC article.** Review.

This article provides an integrative review and discussion of the key neurophysiologic and genetic factors that contribute to blood pressure regulation, the autonomic nervous system (ANS) and manual therapy literature, and the manual therapy and blood pressure literature. ...
- Unravelling functional neurology: does spinal manipulation have an effect on the brain? - a systematic literature review.

Cite Meyer AL, Amorim MA, Schubert M, Schweinhardt P, Leboeuf-Yde C. *Chiropr Man Therap*. 2019 Oct 2;27:60. doi: 10.1186/s12998-019-0265-8. eCollection 2019. PMID: 31632640 **Free PMC article.**

None of these three studies, of 'medium' or 'acceptable' quality, investigated whether the neurophysiological effects reported were associated with clinical benefits. ...
- The Effects Induced by Spinal Manipulative Therapy on the Immune and Endocrine Systems.

Contexte

Segmentaire

SNA

Supra-spinal

Synthèse

# Aller au delà du métamère

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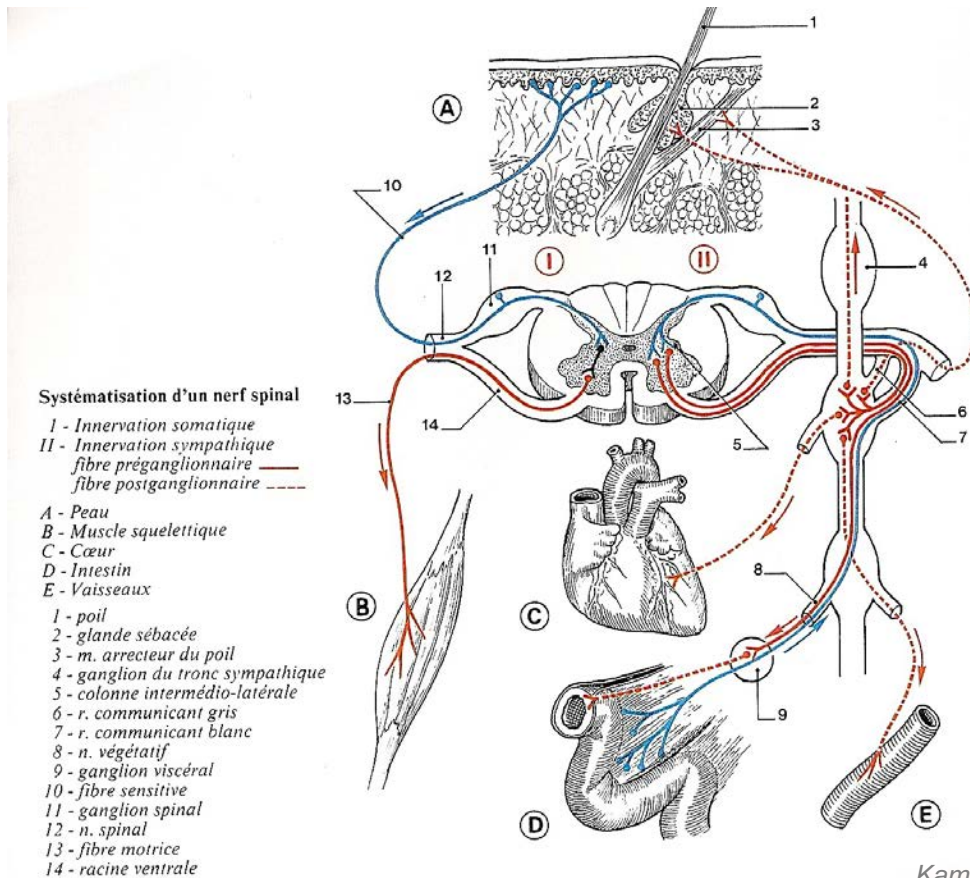
Contexte

Segmentaire

SNA

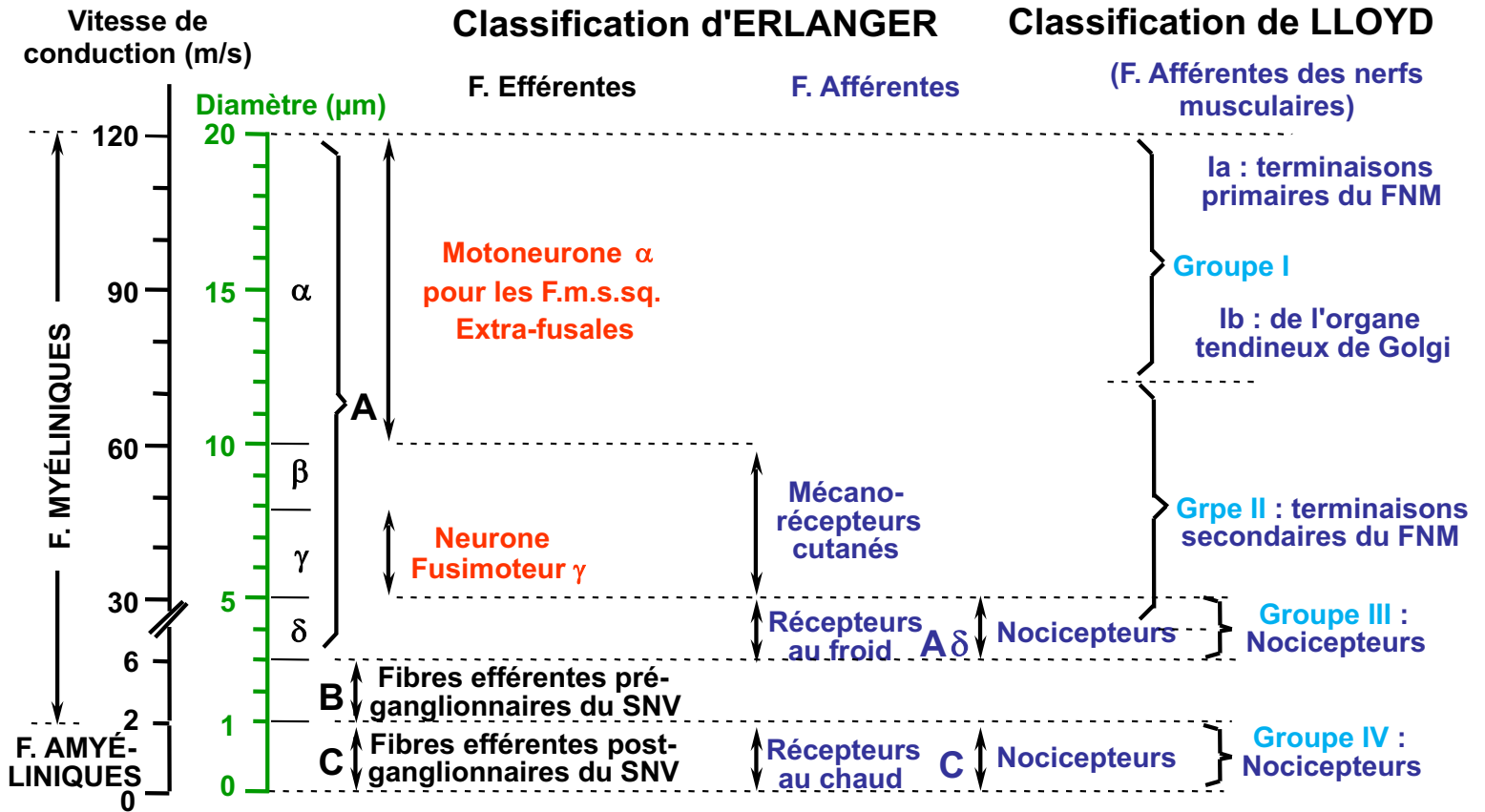
Supra-spinal

Synthèse



Kamina 1983

# Classification des fibres



# Réflexes segmentaires



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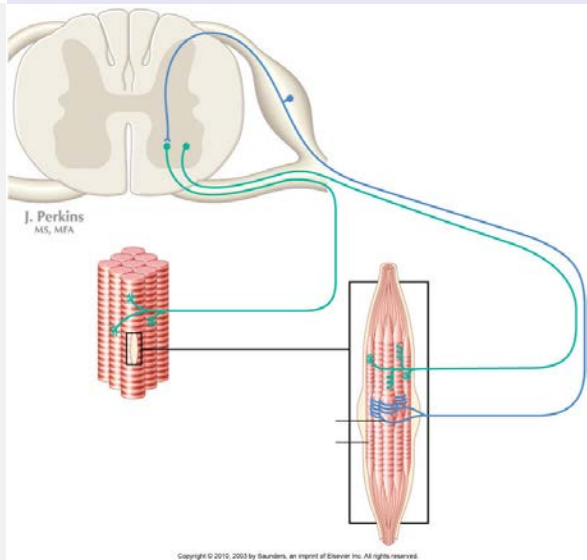
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Segmentaire

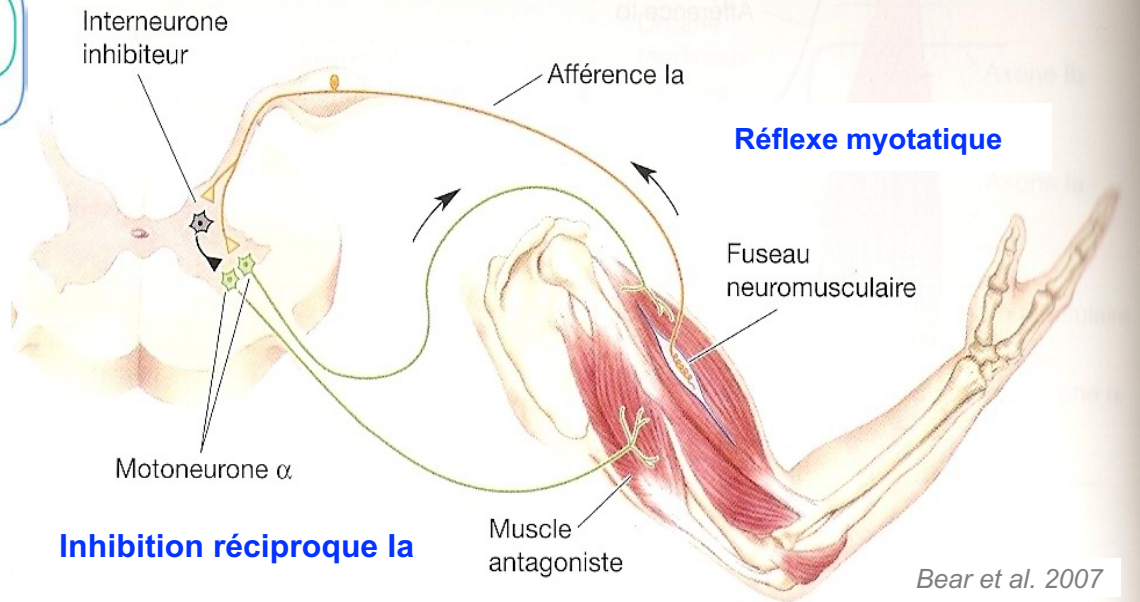
SNA

Supra-spinal

Synthèse



**Fuseau neuromusculaire**

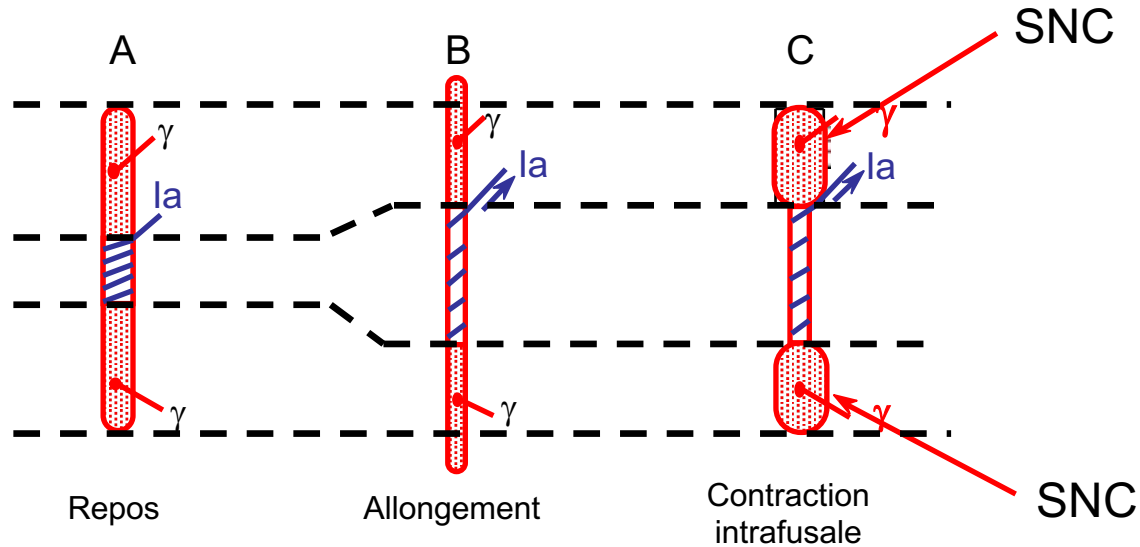


**Inhibition réciproque Ia**

Bear et al. 2007



- **Modulation de la raideur musculaire**
  - Modulation du gain du réflexe myotatique par la boucle gamma



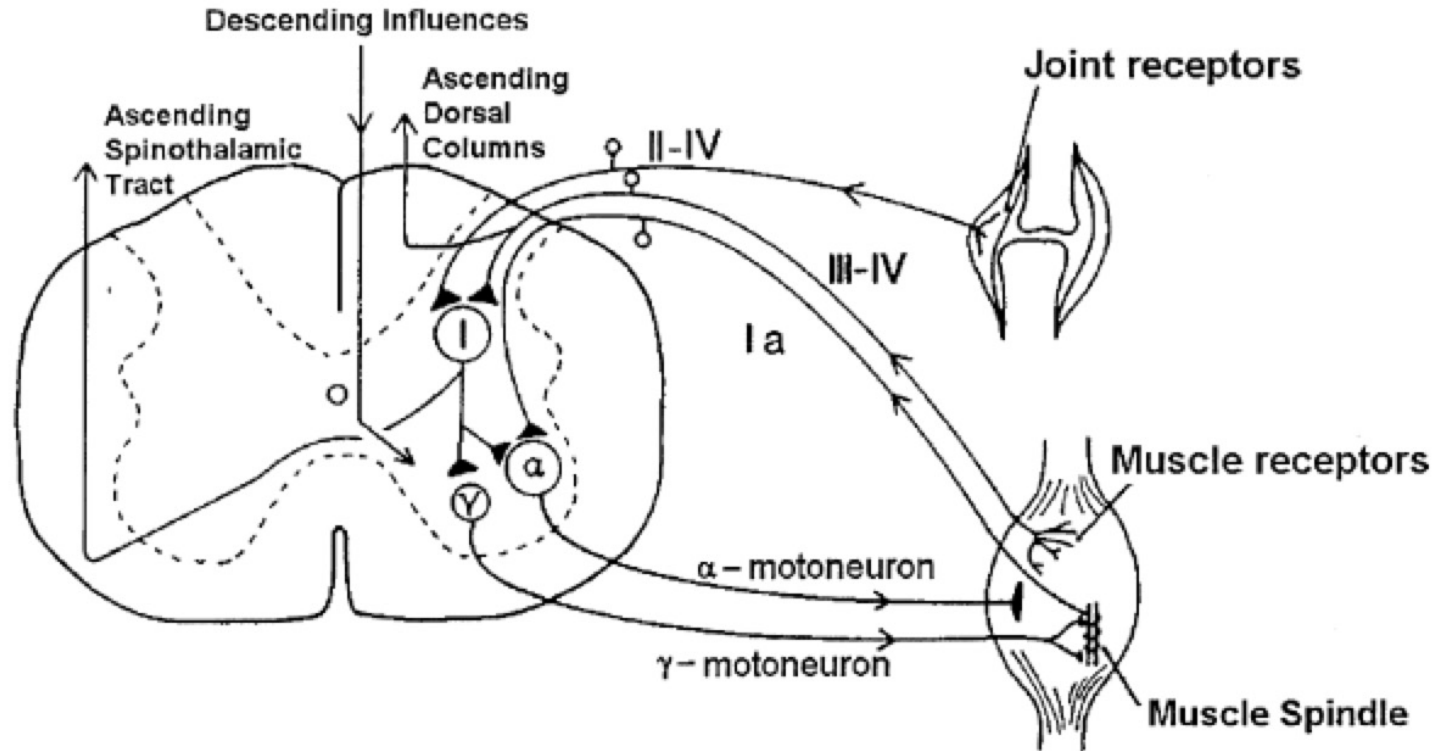
Contexte  
Segmentaire  
SNA  
Supra-spinal  
Synthèse

# Rôle du système fusimoteur gamma



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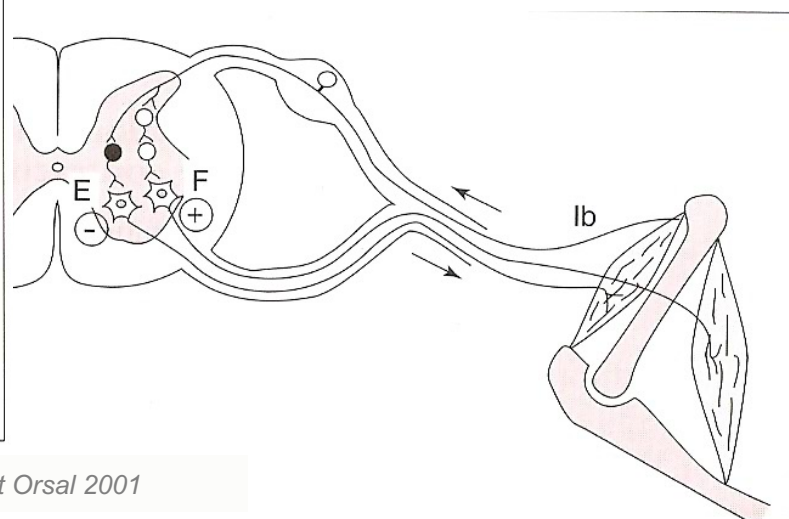
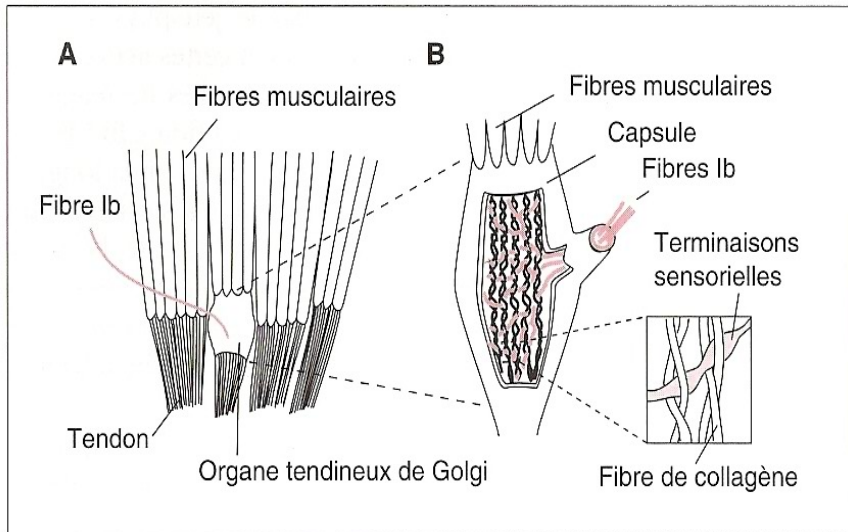
- Contexte
- Segmentaire
- SNA
- Supra-spinal
- Synthèse







Contexte  
Segmentaire  
SNA  
Supra-spinal  
Synthèse



Richard et Orsal 2001

**Inhibition autogénique Ib ou  
réflexe myotatique inverse**

**Contrôle fin de la tension musculaire**

# Réflexes segmentaires et techniques neuro-musculaires

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Contexte

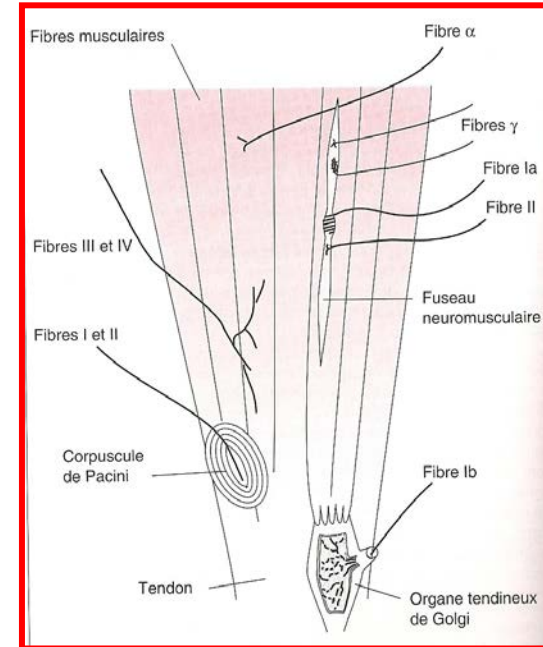
Segmentaire

SNA

Supra-spinal

Synthèse

- Étirement passif du muscle
  - Contraction de ce muscle (réf. myotatique)
  - Relâchement de ce muscle (Inh. autogénique Ib)
- Contraction prolongée d'un muscle (*myotensif*)
  - Dépression post-activation de quelques sec
- Raccourcissement passif du muscle (*Jones*)
  - Relâchement par étirements des antagonistes (inhibition réciproque)
  - Silence proprioceptif de ce muscle ...

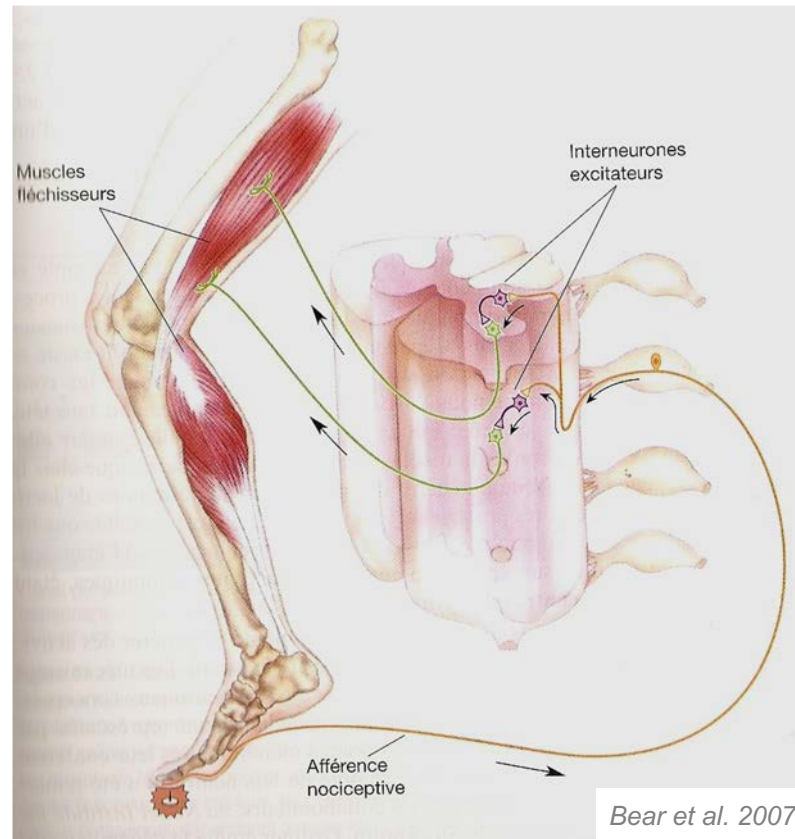


Richard et Orsal 2001



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## Réflexe de protection homolatéral de flexion et controlatéral d'extension



Bear et al. 2007

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Contexte

Segmentaire

SNA

Supra-spinal

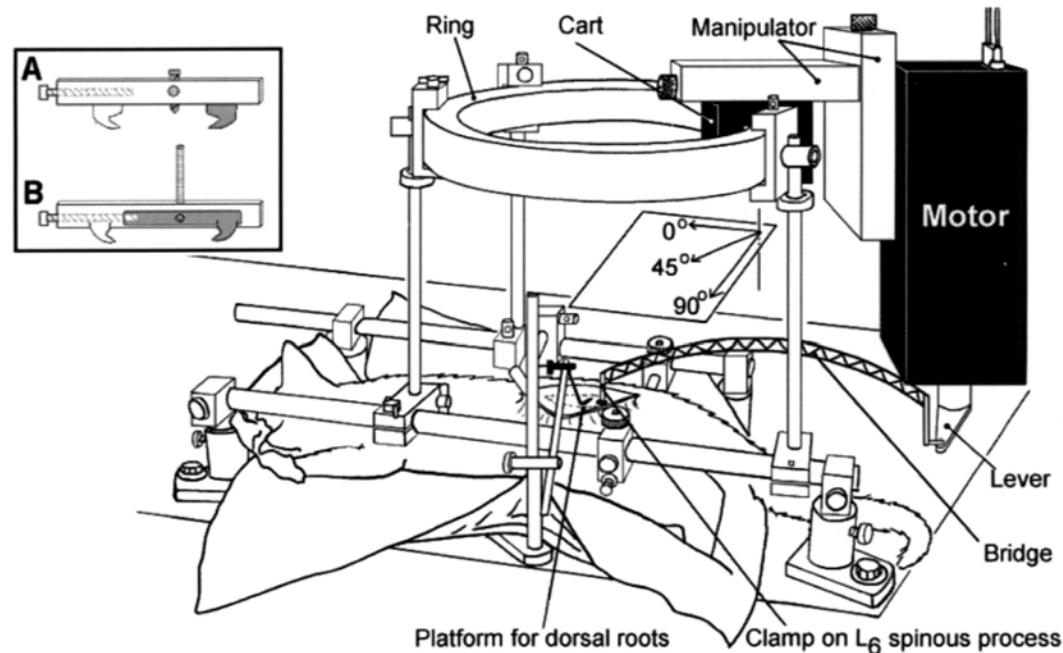
Synthèse



<http://criztina.over-blog.com/article-14974146.html>

HVLA rachis

- Décharge des propriocepteurs
  - FNM, OTG et Pacini
- Repos, mise en tension puis impulsion (2 x 2 modalités)



Contexte

Segmentaire

SNA

Supra-spinal

Synthèse

- Illustrations pour le FNM
  - Période de silence post-impulsion variable

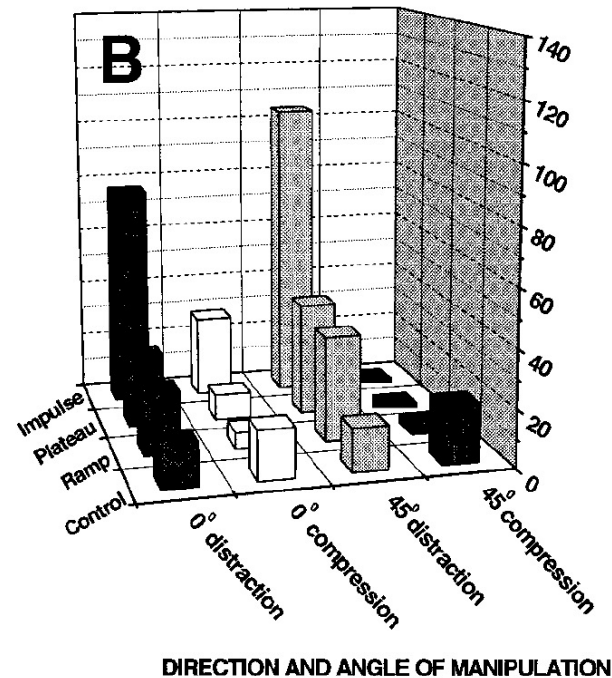
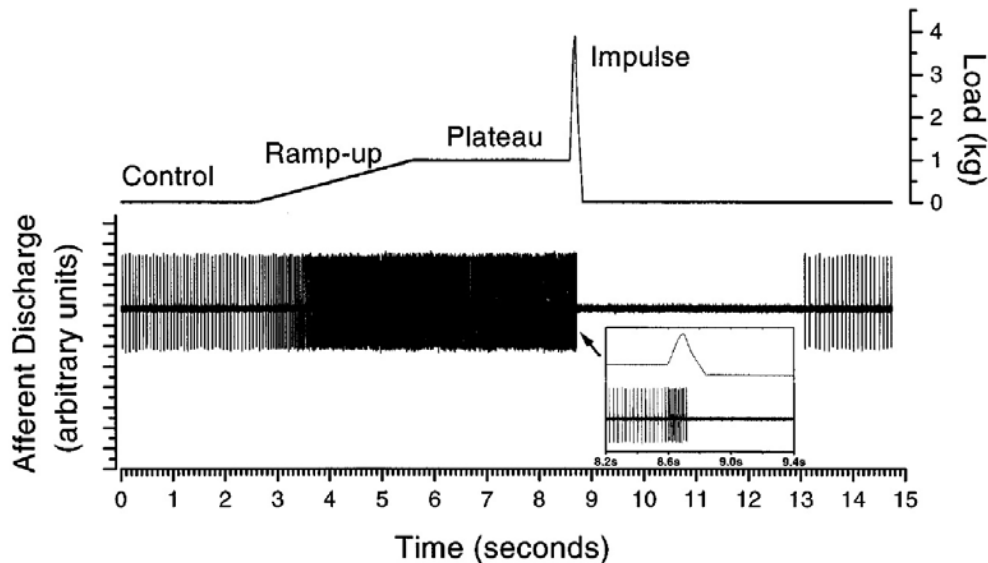
Contexte

Segmentaire

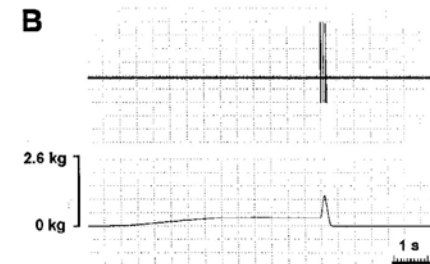
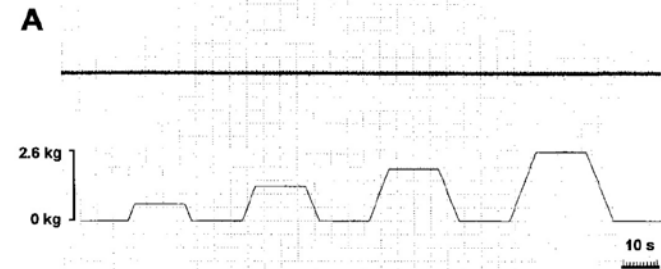
SNA

Supra-spinal

Synthèse

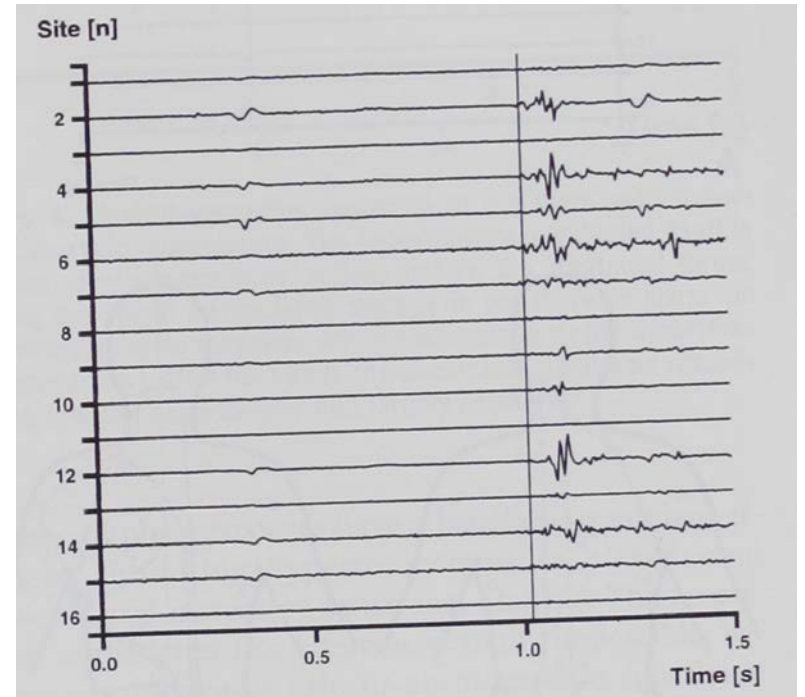
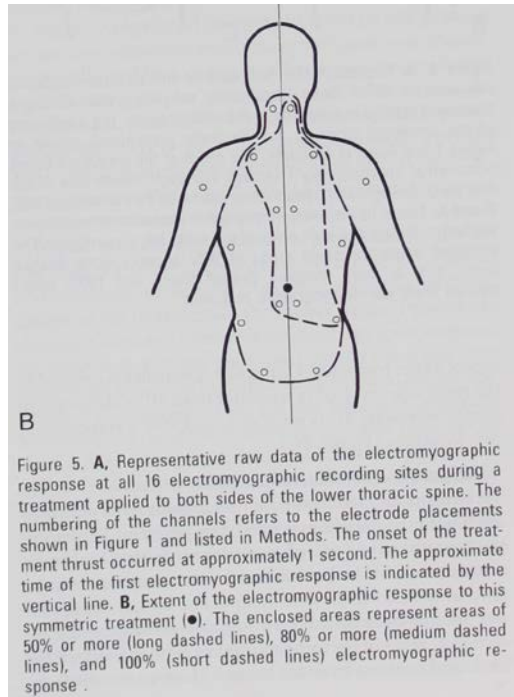


- Co-activation FNM & OTG
  - Lors de la mise en tension < impulsion
  - En distraction > compression
  - Pacini lors de l'impulsion
- Période de silence post-impulsion
- Mise en tension ≠ placebo
- HVLA ≠ mise en tension



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- HVLA cervico-thoracique en procubitus – lombo-sacré en latéro-cubitus
- EMG concomitant





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- Réponse 50-200 ms → activité réflexe
- Activation symétrique en cervico-thoracique vs latéralisé en lombo-sacré
  - Résolution de contractures

Contexte

Segmentaire

SNA

Supra-spinal

Synthèse

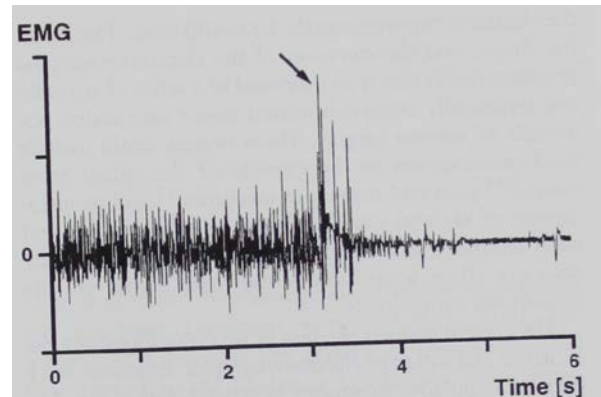
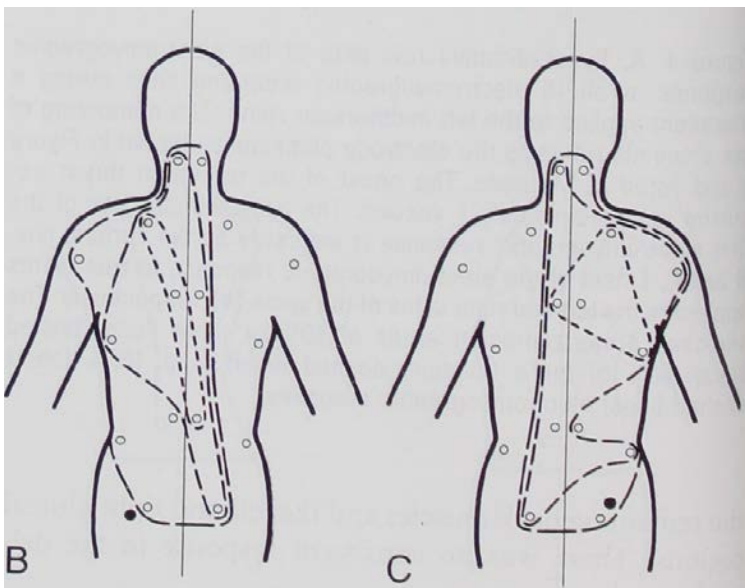


Figure 8. Electromyographic response in a patient with hypertonic thoracic musculature. The hypertonicity manifested itself in intense electromyographic activity before the treatment thrust. During the spinal manipulative therapy in the thoracic spine, an electromyographic response was superimposed on the hypertonic activity (arrow). After the thrust, the electromyograph was virtually silent, and the hypertonicity had largely resolved.

# Étude du système nerveux autonome



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Bull. Acad. Natle Méd., 2013, 197, n° 1, 175-186, séance du 22 janvier 2013

- Variabilité sinusale
- Fréquence cardiaque
- PSA
- Conductance cutanée
- Diamètre pupillaire

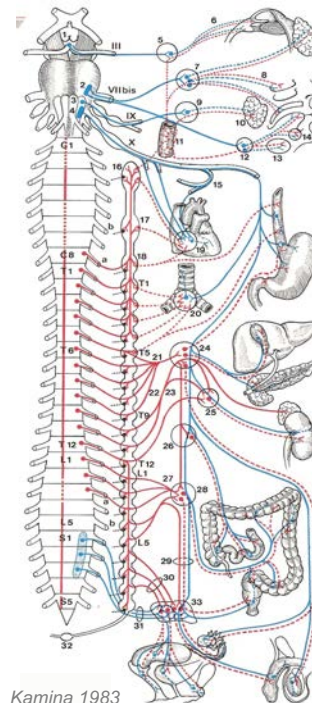
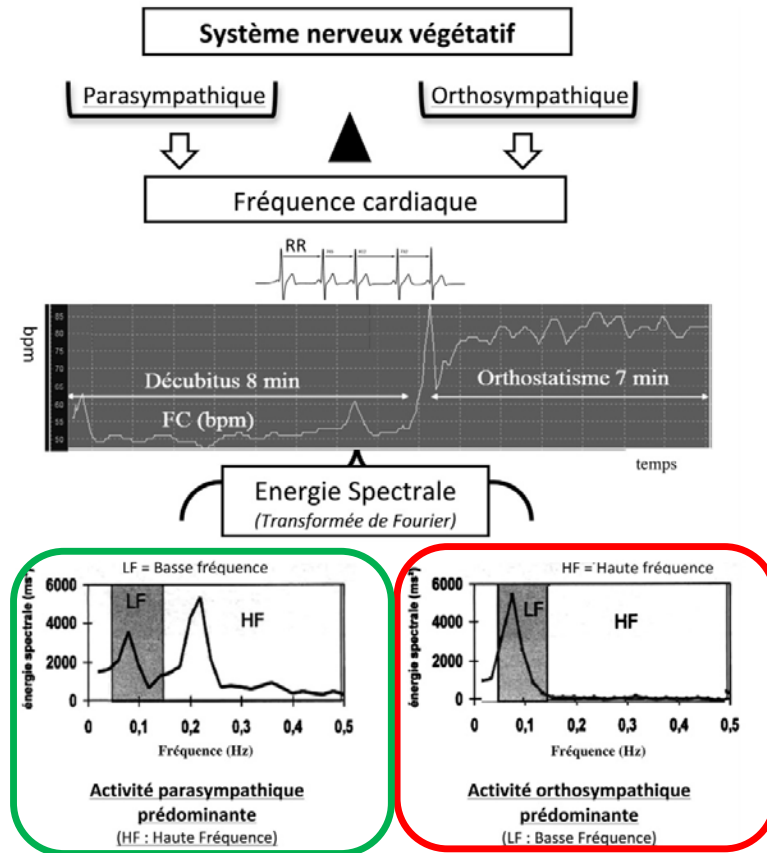


FIGURE 1. — L'équilibre neuro-végétatif

Contexte

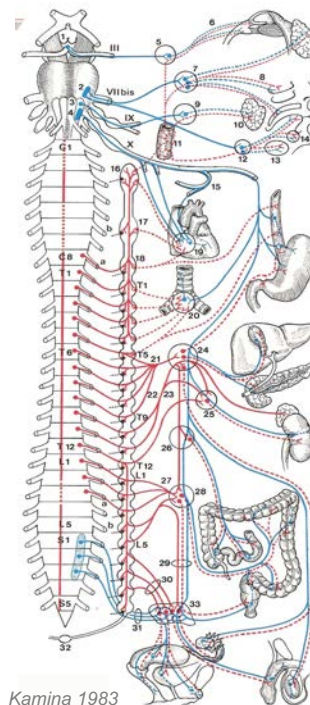
Segmentaire

SNA

Supra-spinal

Synthèse

- HVLA & effets sur le SNA chez des sujets sains
  - Cervico-thoracique: augmente ratio LF/HF → effet Ortho-S +
    - Effet idem mais moindre en thoraco-lombaire
  - Cervical haut = diminue ratio LF/HF → effet Para-S +
  
- Effets variables chez les sujets douloureux
  - Stimulus douloureux = effet Ortho-S +
  
- Importance majeure dans l'explication des symptômes et des effets des TM

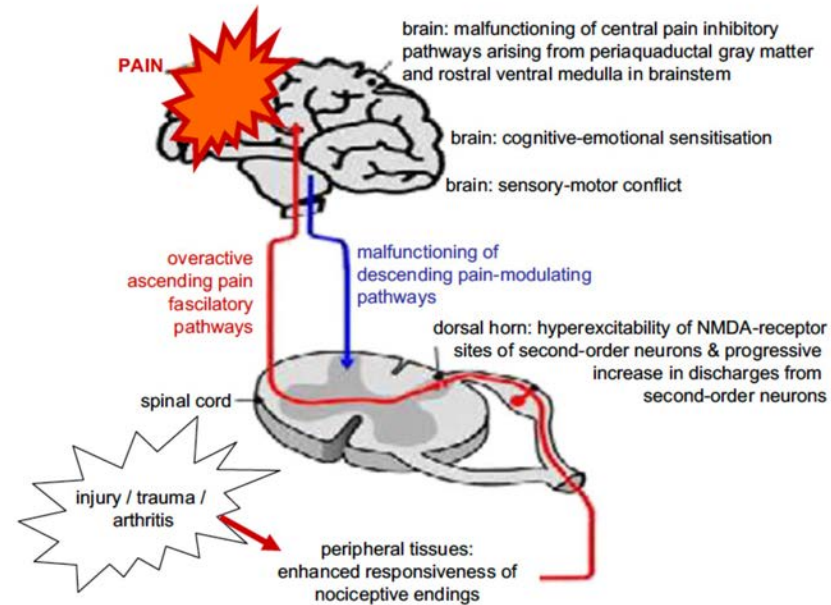


Kamina 1983

# Sensibilisation centrale

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*J. Nijs, B. Van Houdenhove / Manual Therapy 14 (2009) 3–12*



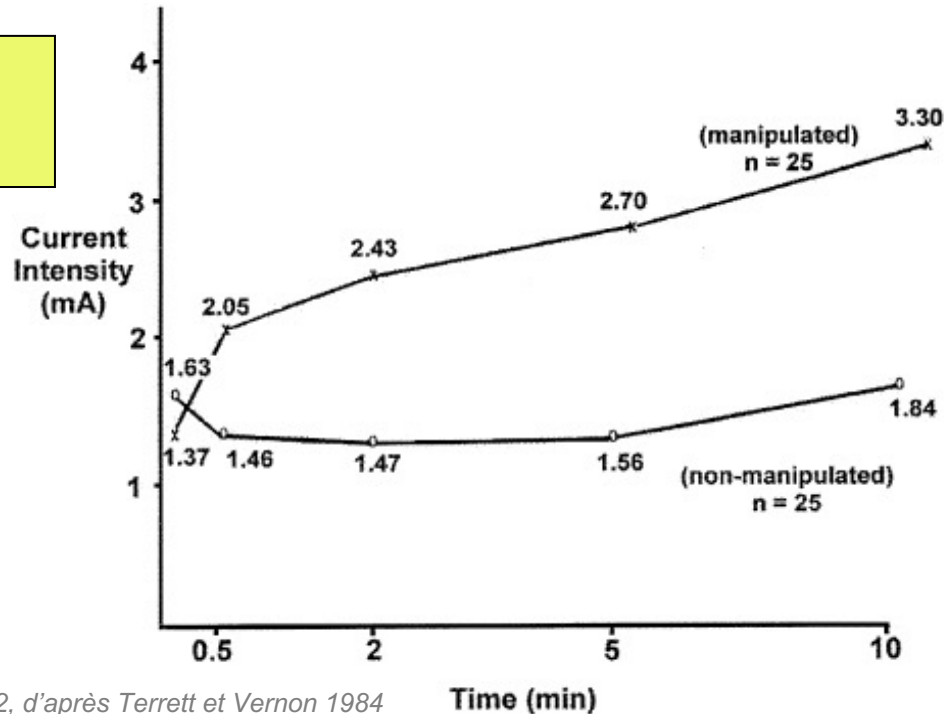
- Voies de la douleur activées pour des stimuli habituellement non douloureux
  - Abaissement du seuil d'activation
  - Activation par la manipulation (non douloureuse)
- Activation du Mn également facilitée
  - contracture

# Effets de la manipulation

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- Diminution du seuil de la douleur cutanée (dans les métamères concernés)

Douleur maximale  
endurée



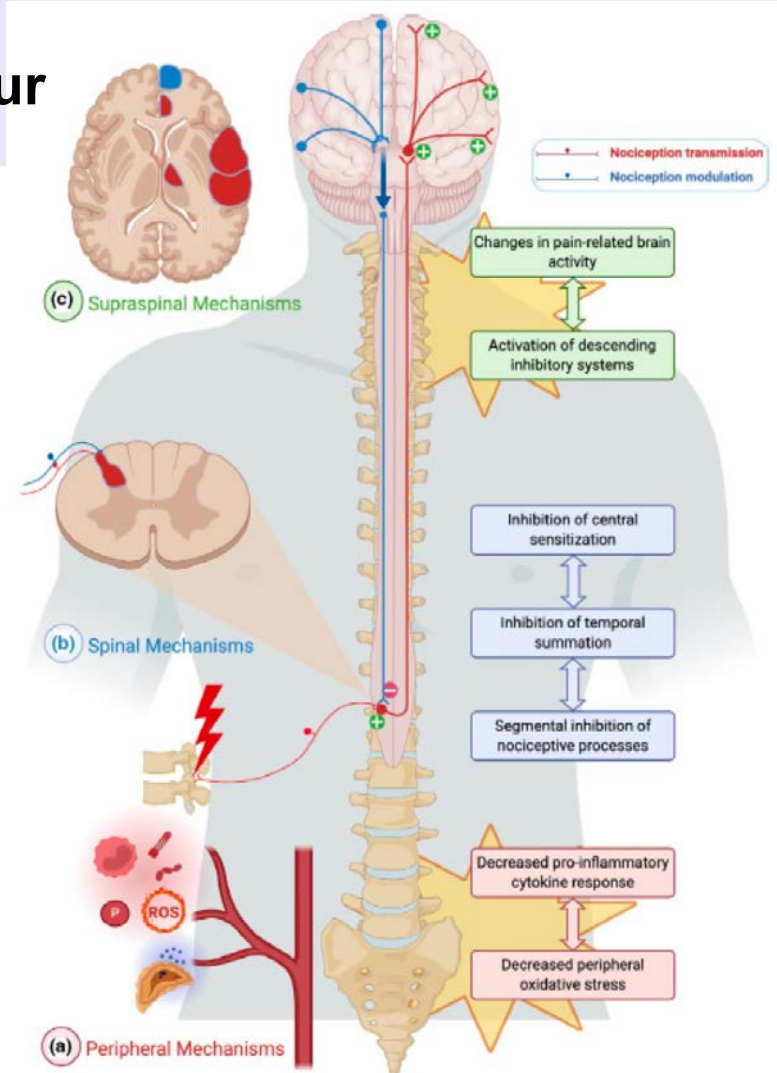
Pickar 2002, d'après Terrett et Vernon 1984

Received: 31 December 2020 | Revised: 5 March 2021 | Accepted: 27 March 2021  
DOI: 10.1002/jcp.1773

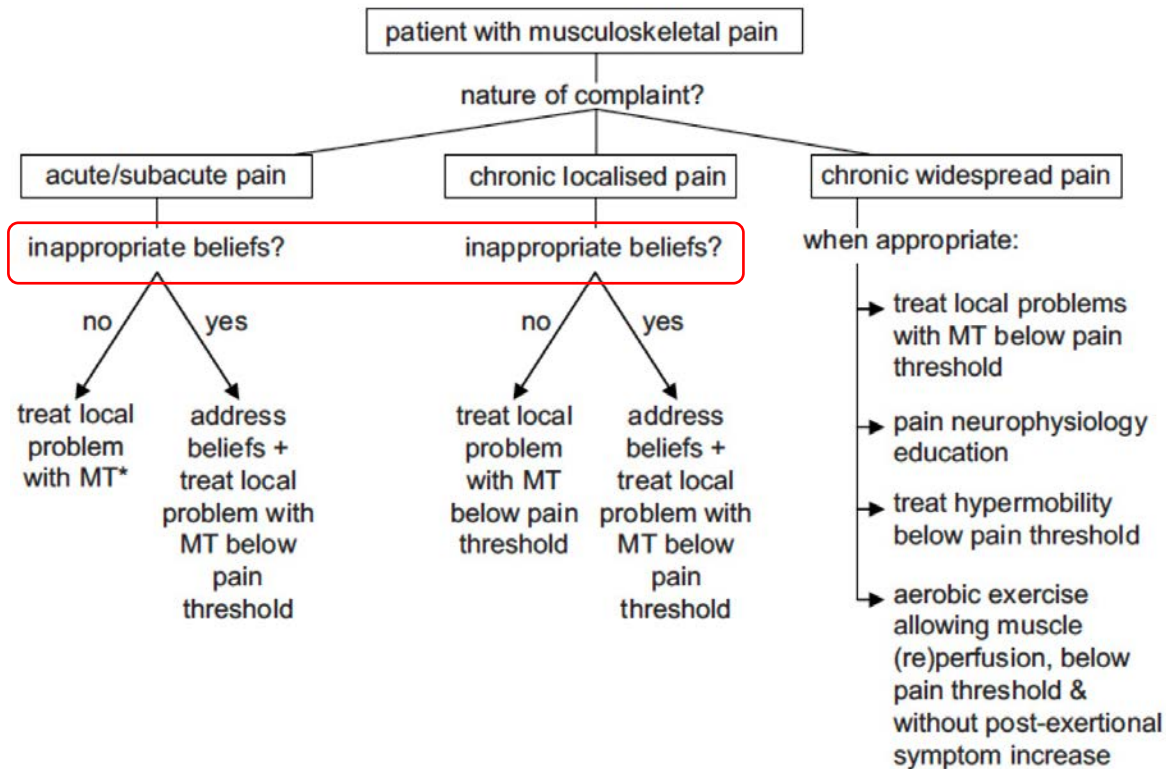
**REVIEW ARTICLE**

## Neurophysiological mechanisms of chiropractic spinal manipulation for spine pain

Carlos Gevers-Montoro<sup>1,2,3</sup> | Benjamin Provencher<sup>1,2</sup> | Martin Descarreaux<sup>1,4</sup>   
Arantxa Ortega de Mues<sup>3</sup> | Mathieu Piché<sup>1,2</sup>



*J. Nijs, B. Van Houdenhove | Manual Therapy 14 (2009) 3–12*



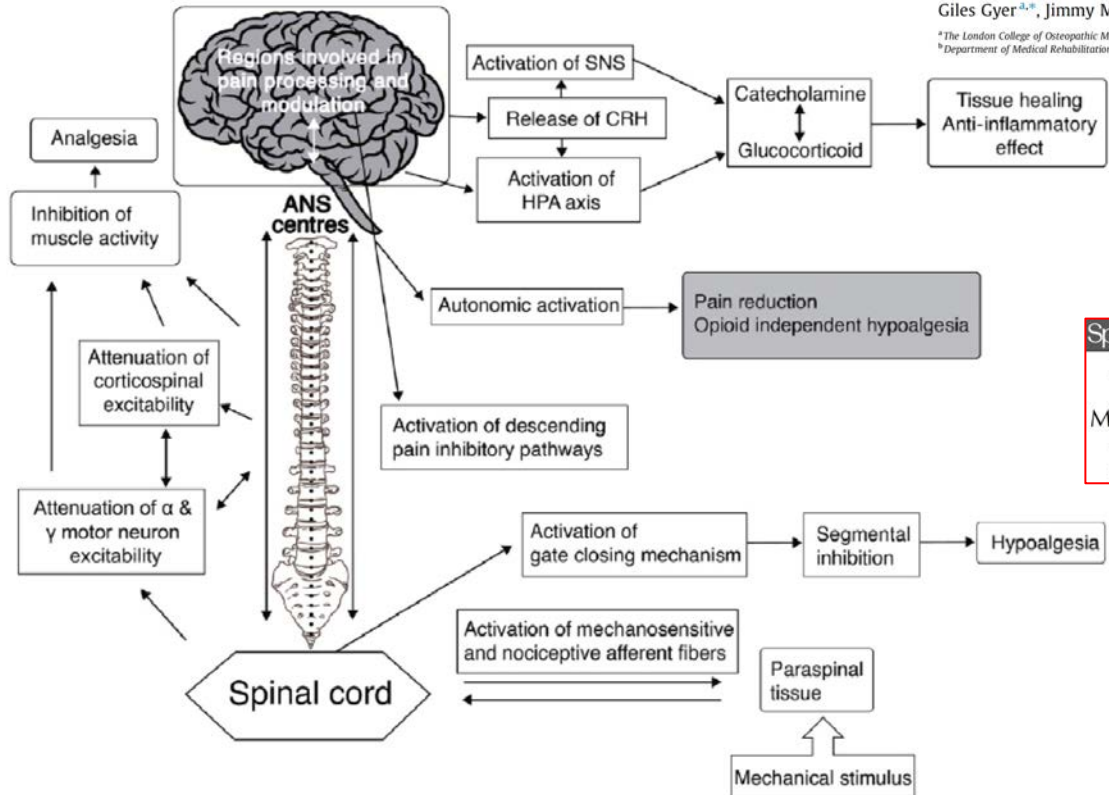
Contexte

Segmentaire

SNA

Supra-spinal

Synthèse



Review

## Spinal manipulation therapy: Is it all about the brain? A current review of the neurophysiological effects of manipulation

Giles Cyer<sup>a,\*</sup>, Jimmy Michael<sup>a</sup>, James Inklebarger<sup>a</sup>, Jaya Shanker Tedla<sup>b</sup>

<sup>a</sup>The London College of Osteopathic Medicine, London NW1 6QH, United Kingdom

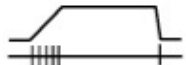
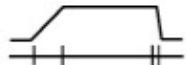
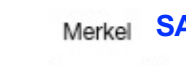

<sup>b</sup>Department of Medical Rehabilitation Sciences, College of Applied Medical Sciences, King Khalid University, 3665 Guraiger, Abha, Saudi Arabia

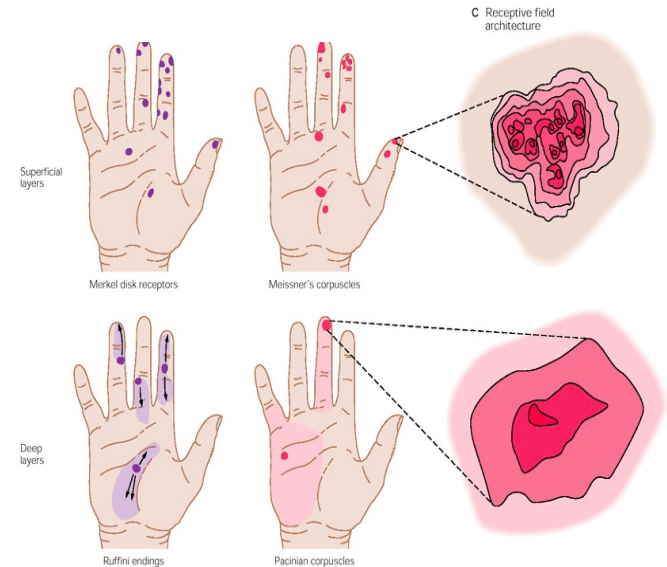




## La peau du patient ... et du thérapeute

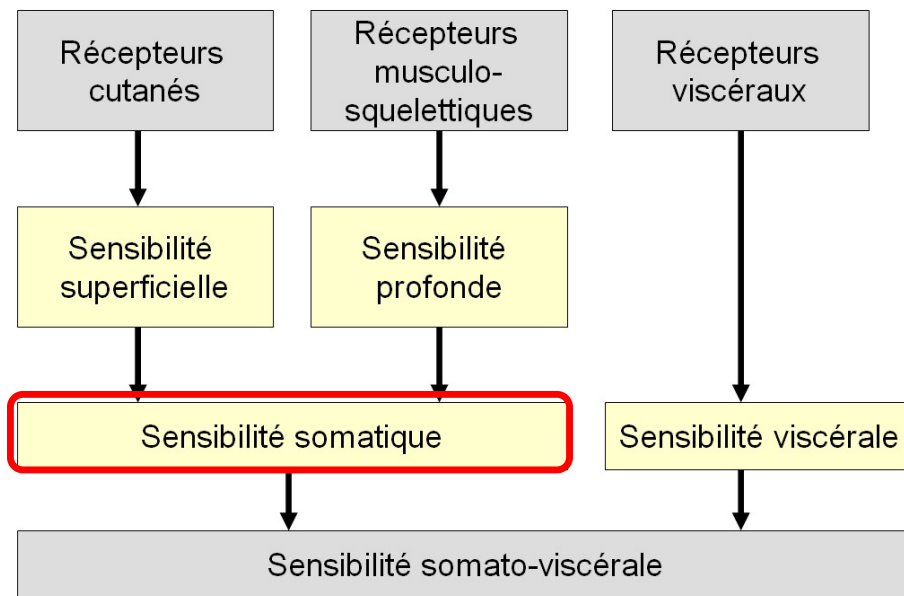
Contexte  
Segmentaire  
SNA  
Supra-spinal  
Synthèse

		Champs récepteurs	
		Petit	Large
Adaptation	Rapide	Meissner <b>FA I</b> 	Pacini <b>FA II</b> 
	Lente	Merkel <b>SA I</b> 	Ruffini <b>SA II</b> 



Kandel, 2008

Slowly / Fastly Adapting (SA / FA) type 1 or 2 mechanoreceptors



D'après Richard et Orsal, 2001

# Thérapie manuelle : orage *proprioceptif* ? *reset* ?

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- **Orage somesthésique** *plutôt que proprioceptif*

- Propriocepteurs
- Récepteurs cutanés
- Nociception

*Cell.* 2011 December 23; 147(7): 1615–1627. doi:10.1016/j.cell.2011.11.027.

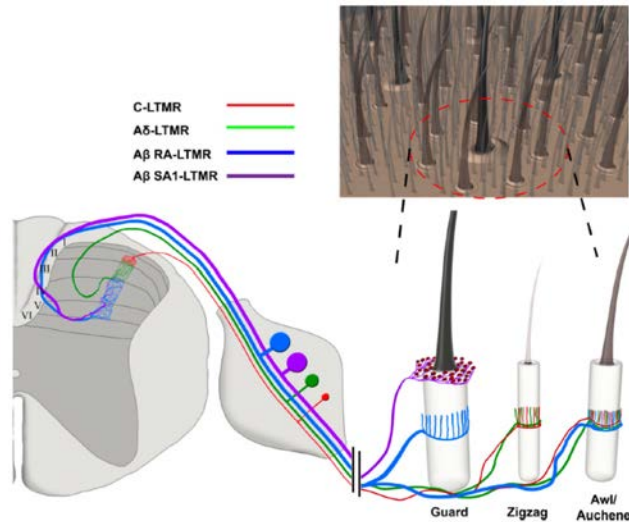
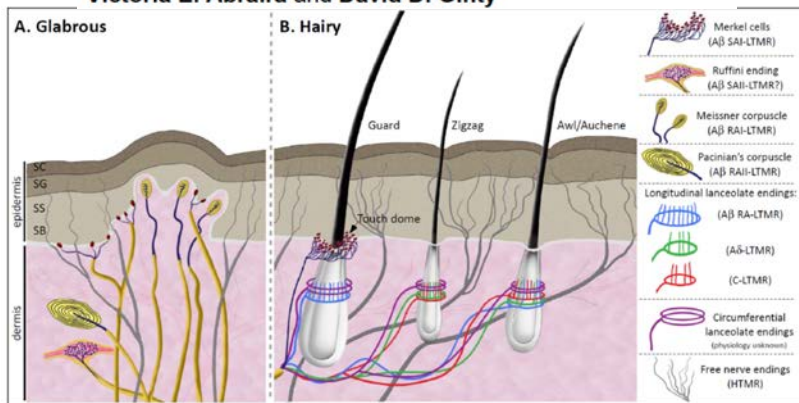
### The functional organization of cutaneous low-threshold mechanosensory neurons

Lishi Li<sup>1,\*</sup>, Michael Rutlin<sup>1,\*</sup>, Victoria E. Abraira<sup>1</sup>, Colleen Cassidy<sup>2</sup>, Laura Kus<sup>3</sup>, Shiaoqing Gong<sup>3</sup>, Michael P. Jankowski<sup>4</sup>, Wenqin Luo<sup>1,5</sup>, Nathaniel Heintz<sup>3</sup>, H. Richard Koerber<sup>1</sup>, C. Jeffery Woodbury<sup>2</sup>, and David D. Ginty<sup>1</sup>

*Neuron.* 2013 August 21; 79(4): . doi:10.1016/j.neuron.2013.07.051.

## The Sensory Neurons of Touch

Victoria E. Abraira and David D. Ginty



Contexte

Segmentaire

SNA

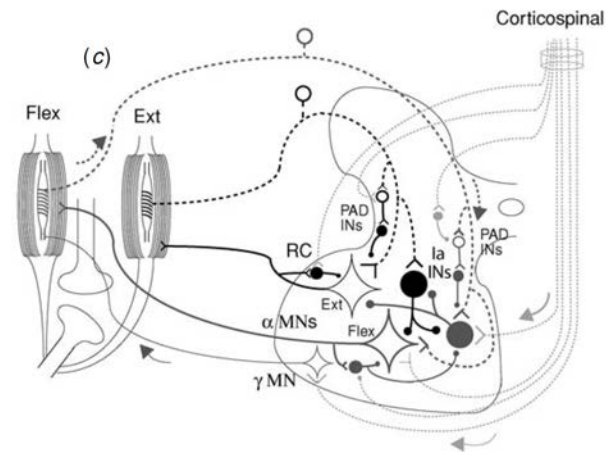
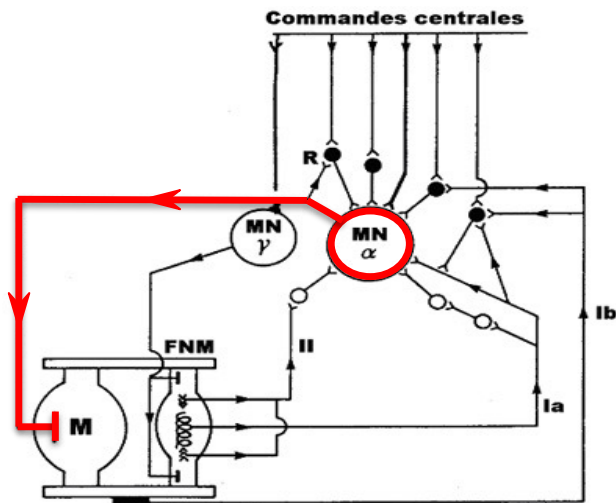
Supra-spinal

Synthèse

# Thérapie manuelle : orage proprioceptif ? reset ?

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- **Orage somesthésique** plutôt que proprioceptif
- **Notion d'intégration sensori-motrice**
  - Modulation supra-spinal

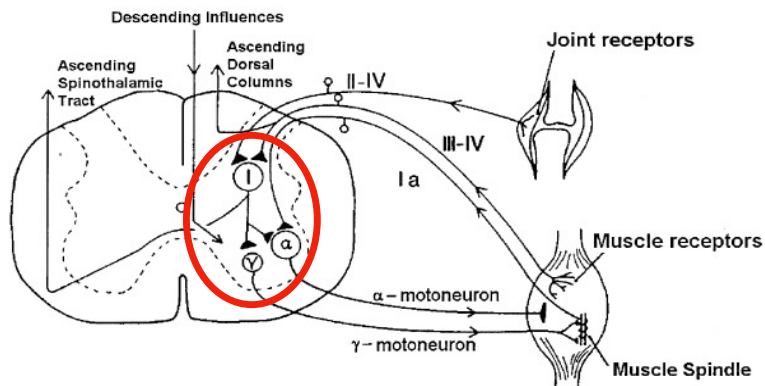


Pierrot-Deseilligny 2005

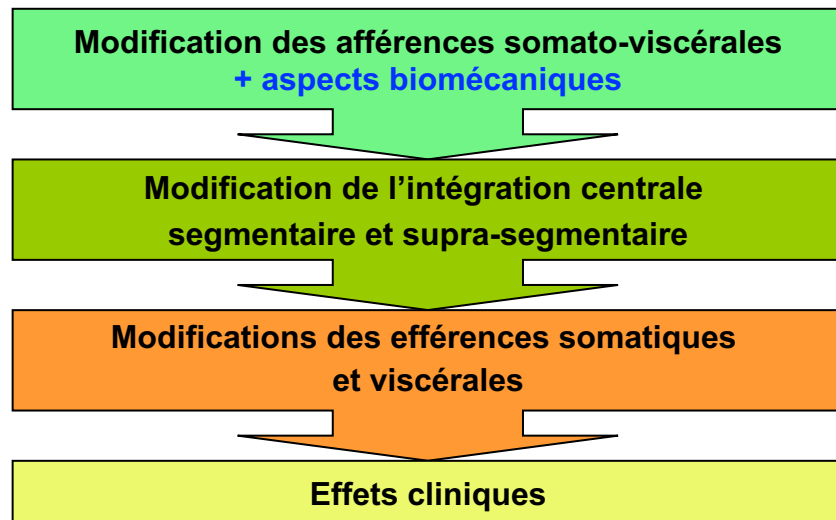
# Thérapie manuelle : orage proprioceptif ? reset ?

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- Technique manuelle → vague d'afférences sur les grosses et petites fibres
- Pourrait « casser » (*fonction 'reset'*) l'emballement des boucles réflexes segmentaires :
  - En diminuant la facilitation des voies de la douleur
  - Par un effet 'gate control'
  - En levant la facilitation de la boucle gamma
  - ...



Pickar 2002

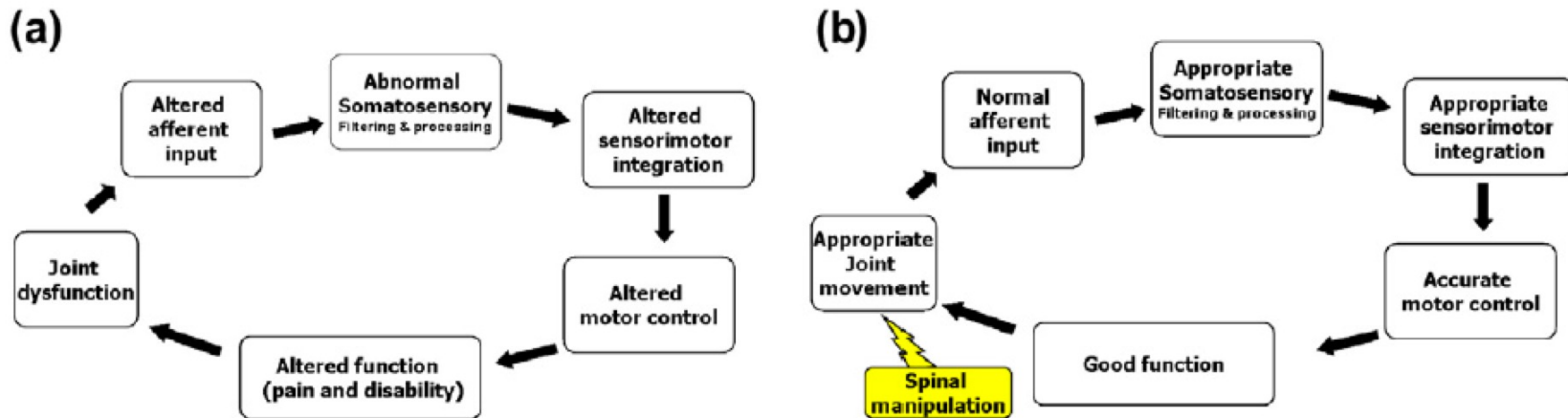


# Thérapie manuelle : orage proprioceptif ? reset ?

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- **Orage somesthésique** plutôt que proprioceptif
- **Notion d'intégration sensori-motrice**
  - Modulation supra-spinale

*H. Haavik, B. Murphy / Journal of Electromyography and Kinesiology 22 (2012) 768-776*



# Le toucher et le regard !

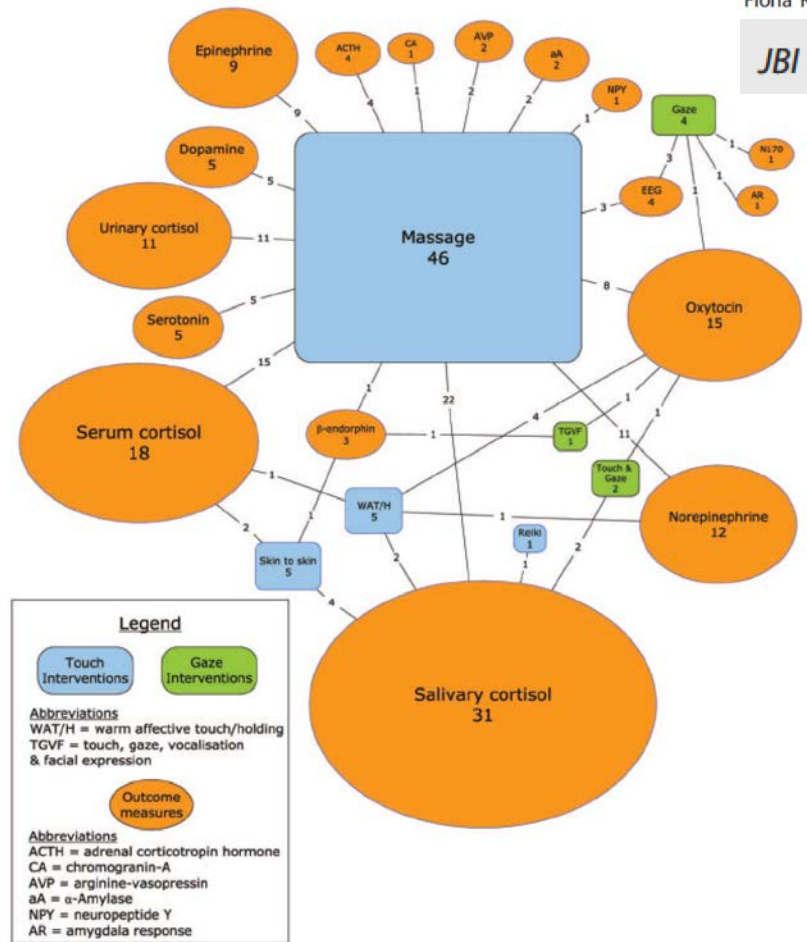
## Neurophysiology of human touch and eye gaze in therapeutic relationships and healing: a scoping review

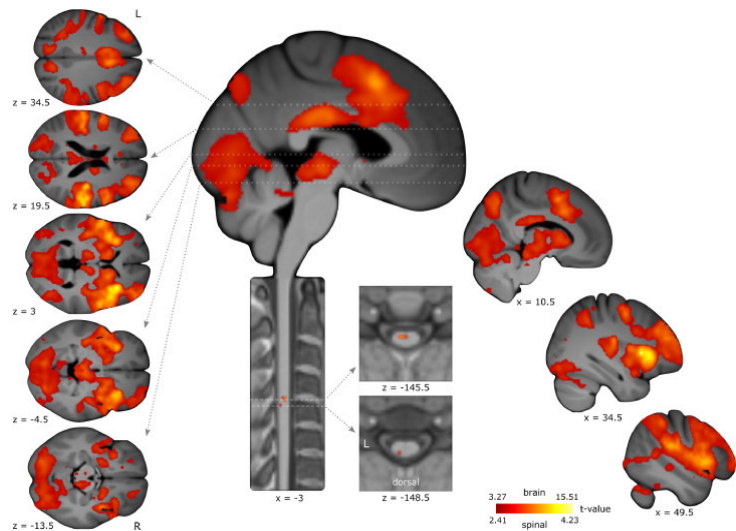
Fiona Kerr<sup>1,3,4,5</sup> · Rick Wiechula<sup>1,2</sup> · Rebecca Feo<sup>1,2</sup> · Tim Schultz<sup>1,2</sup> · Alison Kitson<sup>1,2</sup>

*JBI Database System Rev Implement Rep 2019; 17(2):209–247.*

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Contexte  
Segmentaire  
SNA  
Supra-spinal  
Synthèse





## Unravelling functional neurology: does spinal manipulation have an effect on the brain? - a systematic literature review

Anne-Laure Meyer<sup>1,2,3\*</sup>, Michel-Ange Amorim<sup>1,2</sup>, Martin Schubert<sup>4</sup>, Petra Schweinhardt<sup>5</sup> and Charlotte Leboeuf-Yde<sup>1,2,3,6</sup>



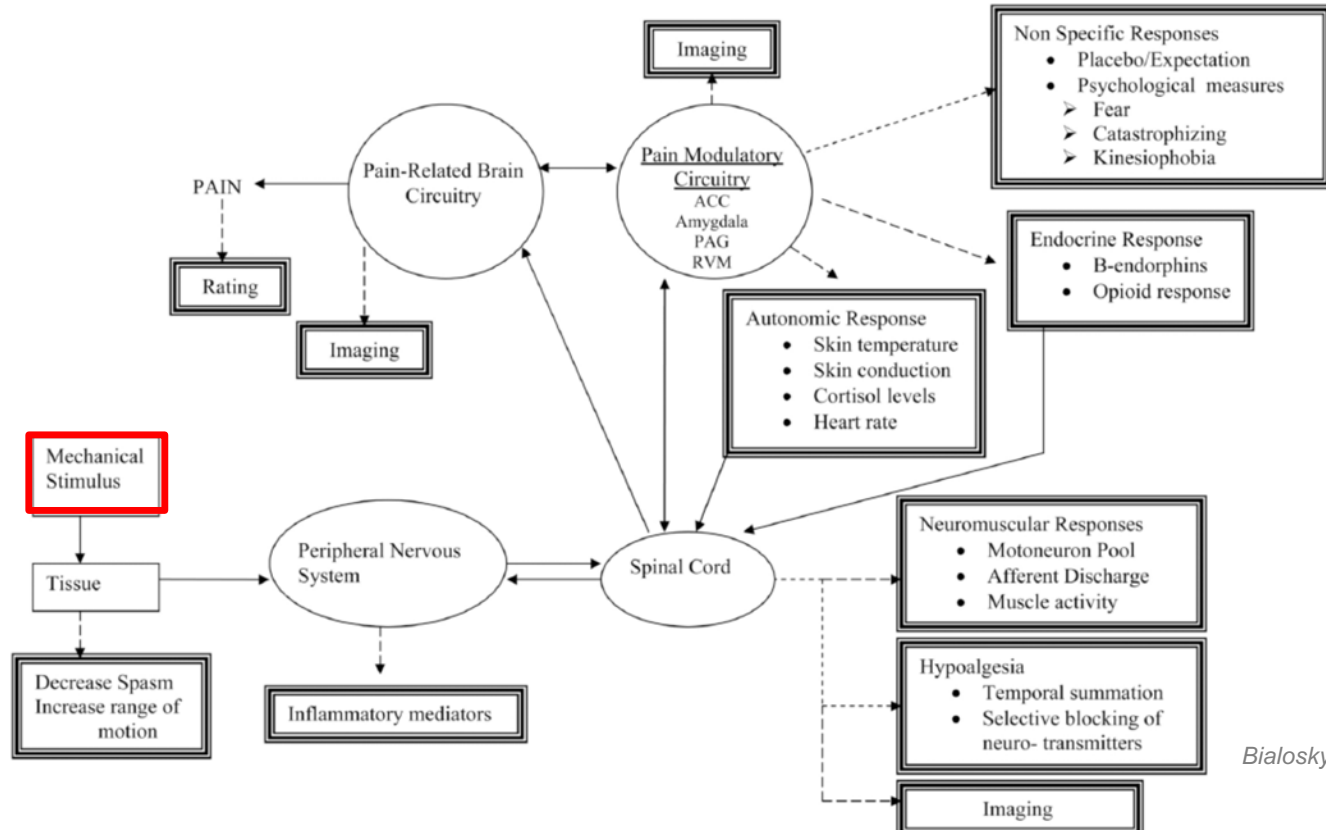
Tinnermann et al. 2021



# Modèle global

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Contexte  
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SNA  
Supra-spinal  
Synthèse



Bialosky et al. 2009

# Modèle global – Effets non-spécifiques

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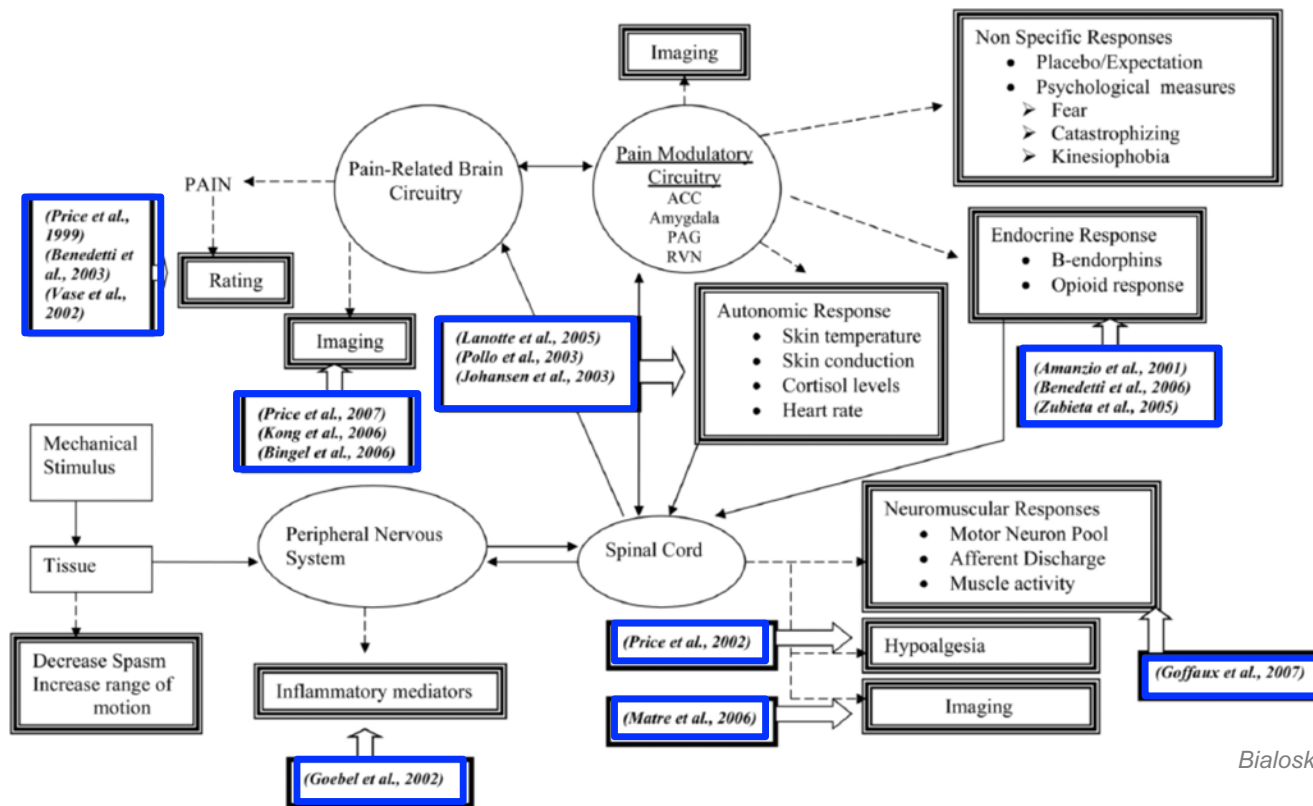
Contexte

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Supra-spinal

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Bialosky et al. 2009

Masterclass

## Enhance placebo, avoid nocebo: How contextual factors affect physiotherapy outcomes

Marco Testa , Giacomo Rossetini

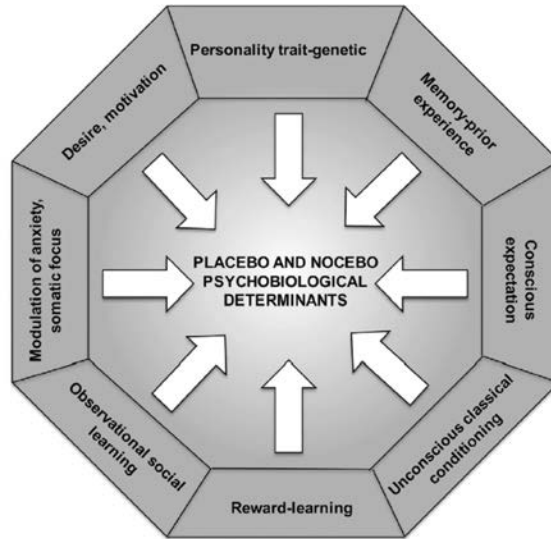


Fig. 1. Placebo and nocebo psychobiological determinants.

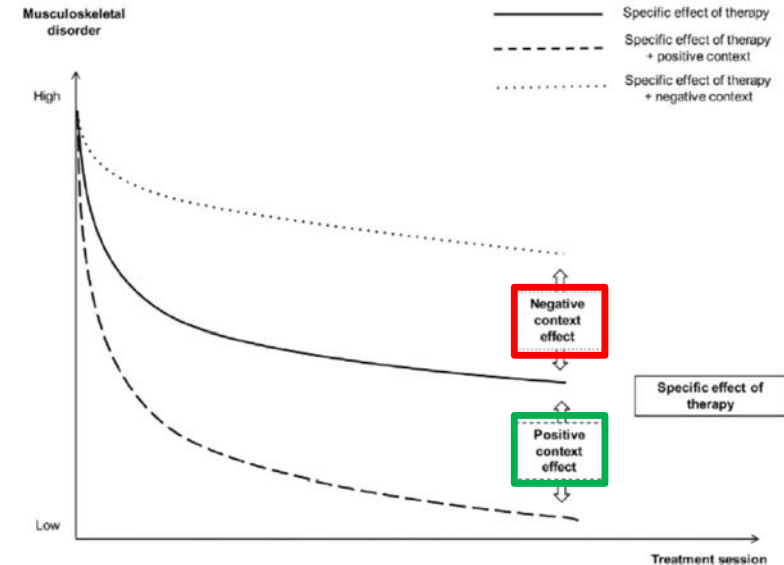


Fig. 4. The modulation of the specific effect of therapy by positive and negative context.

➔ **Soyez empathique > bon techniquement !!**

# Et évitez le manque de tact !

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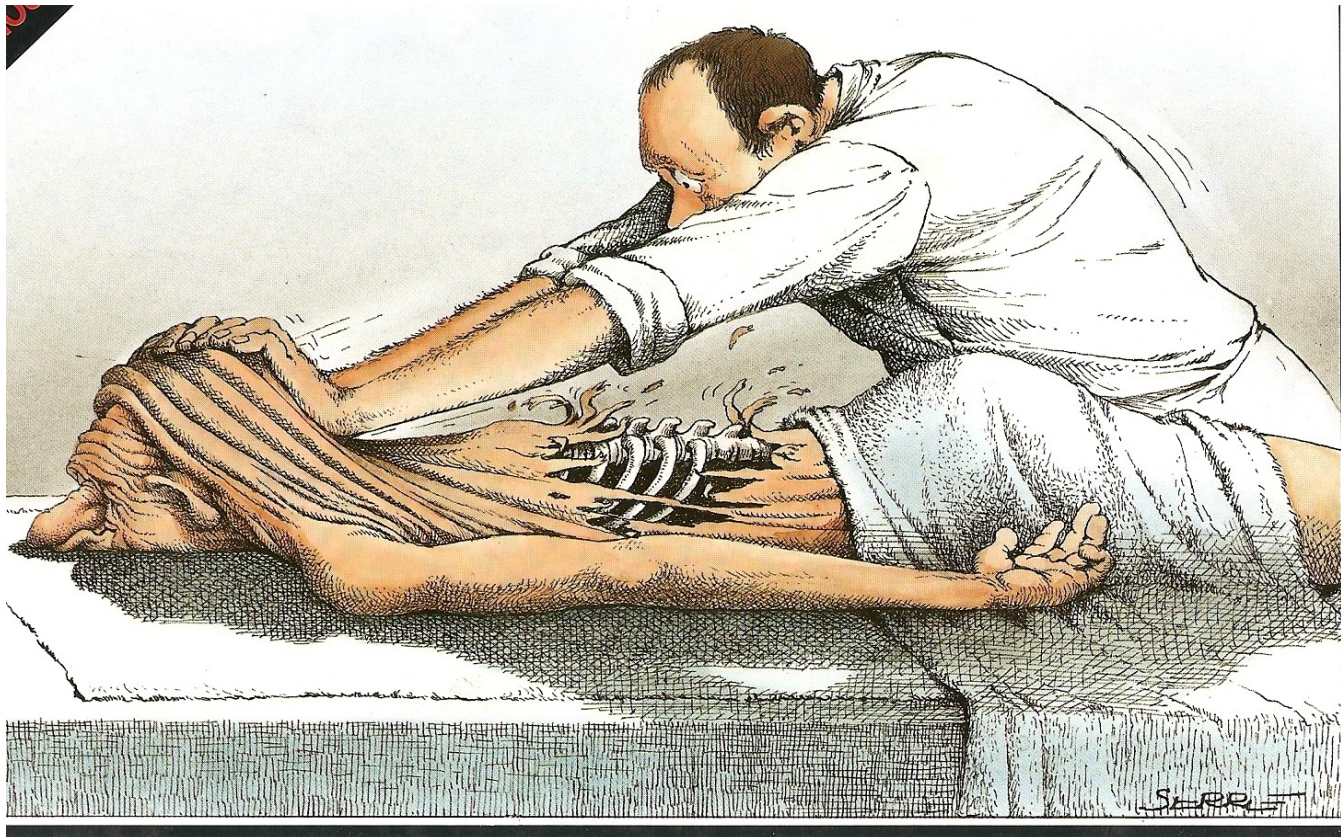
Contexte

Segmentaire

SNA

Supra-spinal

Synthèse



# Neurophysiologie et TM : perspectives ?

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- Guide pour le choix de la technique ?

- Sensibilisation centrale
- Les techniques que vous maîtrisez
- Les représentations et attentes du patient

ECOLE DE MASSAGE DU TEMPLE WAT PHO  
DEUX EXPERIENCES:



- Une voie de recherche ?

- Équipes actives sur le sujet : chiropracteurs ++
- Intérêt pour :
  - Le choix des techniques
  - Le mode d'administration
  - La part des choses entre facteurs « techniques » et facteurs « prise en charge »

