

Interpreting the psychophysics of chronic pain using electrophysiological responses

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**Chronic pain
patients**



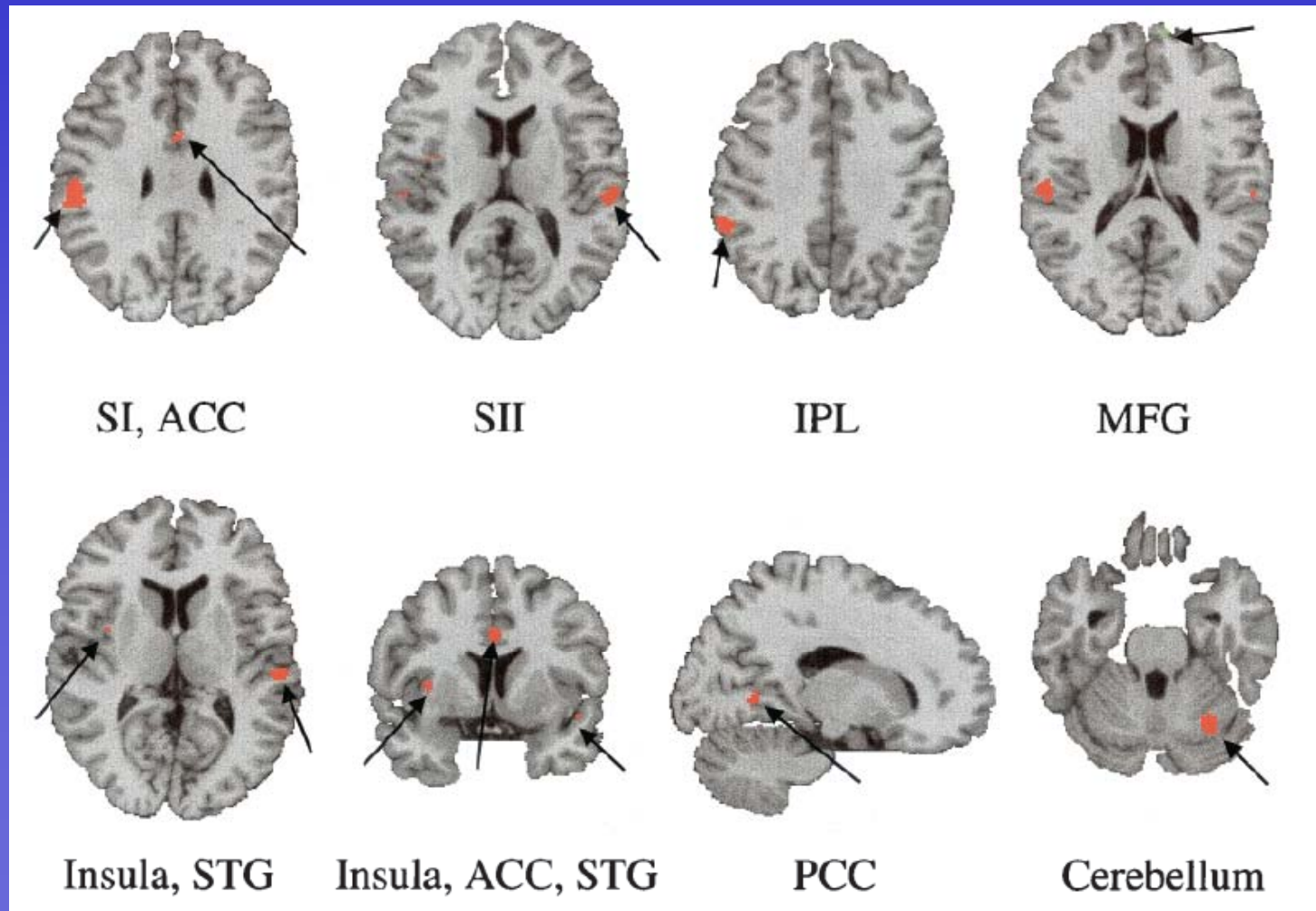
**Greater sensitivity to
pain provocation than
controls since they
require
less mechanical
pressure,
less electrical current,
or
less heat
to feel pain.**

**Chronic pain
patients**

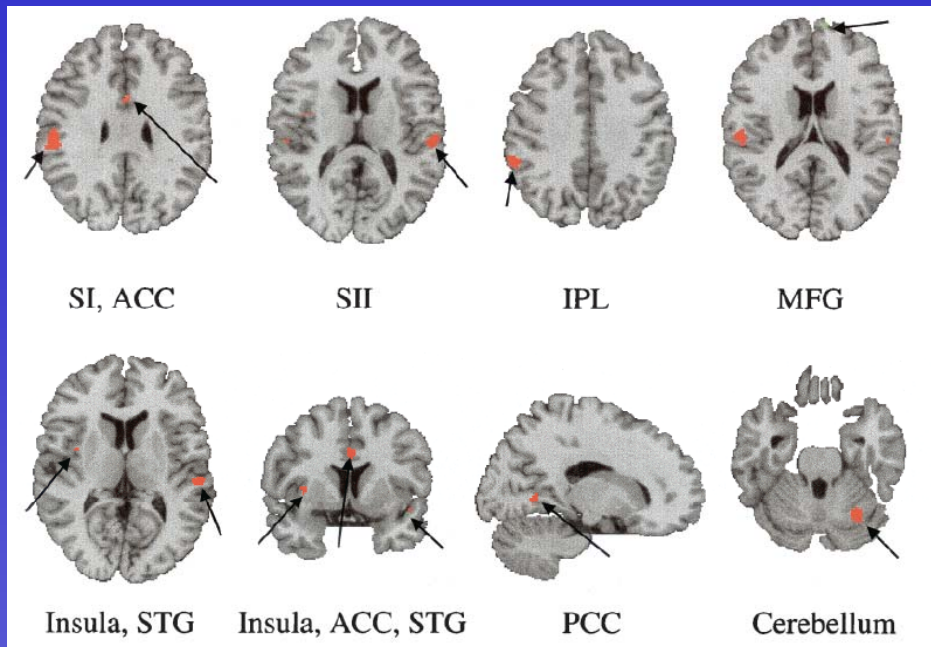


**Demonstrate augmented
processing of
nociceptive input,
supporting the idea that
chronic pain is related to
some form of central
nervous system
dysfunction.**

Conditions of equal stimulus intensity FM > Controls



Gracely et al., 2002, *Arthritis and Rheumatism*



close relationship
between verbal
reports of pain and
brain activity

Augmented pain
processing and
pain reporting at
equal stimulus
intensity



Judgment bias – chronic pain
induced differences in psycho-
affective well-being

Central sensitization

Psycho-affective contributions

Chronic pain
patients



Pain catastrophising,
depression, and
expectations of
hyperalgesia
influence verbal reports
of pain and modulate
brain activity.

Gracely et al., 2004, *Brain*

Giesecke et al., 2005, *Arthritis
and Rheumatism*

Ploghaus et al., 1999, *Science*

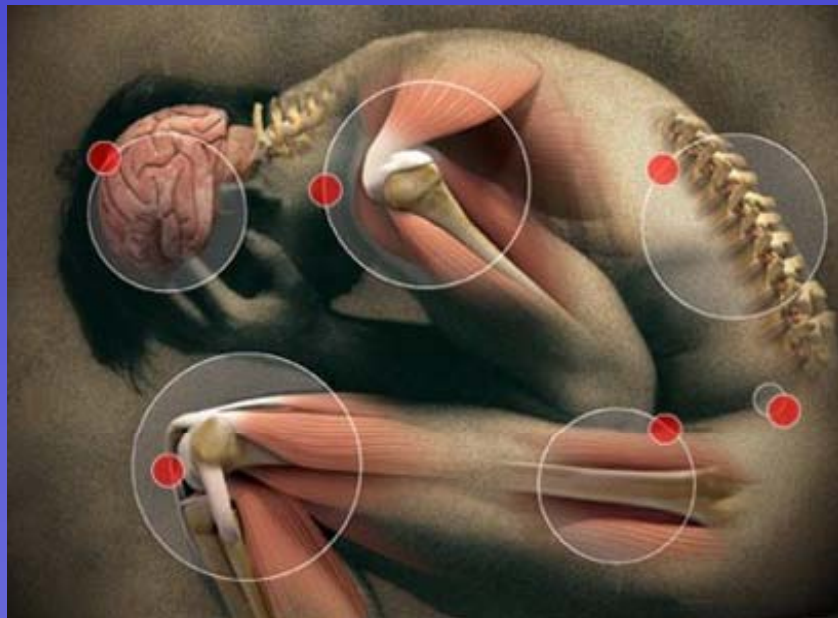
Central sensitization

Chronic pain patients



Demonstrate pain referral to greater body areas than controls

Sorensen et al., 1998, *J. Rheumatology*



Show increased temporal summation to rapidly presented stimuli

Staud et al., 2001, *Pain*

Descending Inhibitory deficit

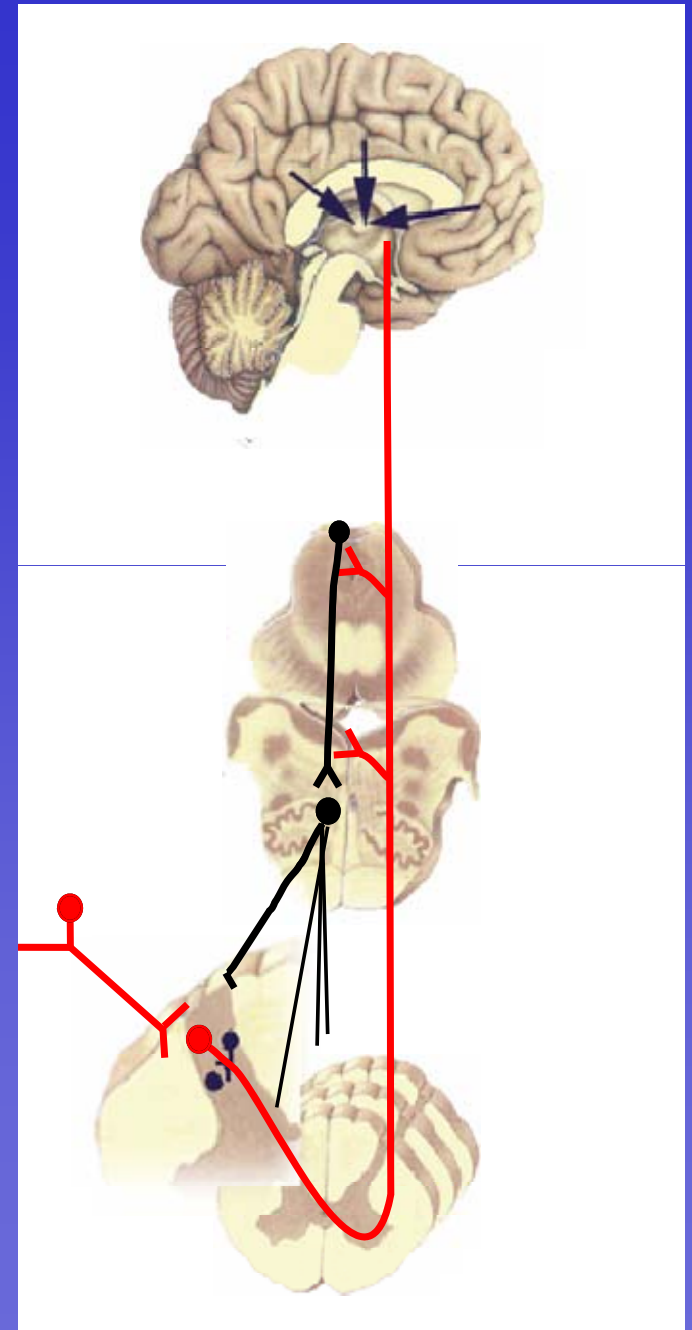


Lautenbacher & Rollman, 1997, Clinical J. Pain
Kosek et al., 1997, Pain
Julien et al., 2005, Pain

Descending Inhibitory Pathways

Triggered by strong incoming nociceptive activity

Involve descending projections (NA, 5HT, Enk.)



**Offset the development of chronic
post-operative pain**



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PAIN

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Prediction of chronic post-operative pain: Pre-operative DNIC testing identifies patients at risk

David Yarnitsky ^{a,*}, Yonathan Crispel ^a, Elon Eisenberg ^b, Yelena Granovsky ^a,
Alon Ben-Nun ^c, Elliot Sprecher ^a, Lael-Anson Best ^c, Michal Granot ^d

^a Department of Neurology, Rambam Health Care Campus, and Laboratory of Clinical Neurophysiology, Faculty of Medicine, Technion, Israel

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^d Faculty of Social Welfare and Health Studies, University of Haifa, Haifa, Israel

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64 patients scheduled for thoracotomy

1. Pain sensitivity before surgery
2. Strength of descending inhibitory responses before surgery.

Pre-operative pain sensitivity of patients



Elevated levels of acute post-operative pain



The presence of weak descending inhibitory responses



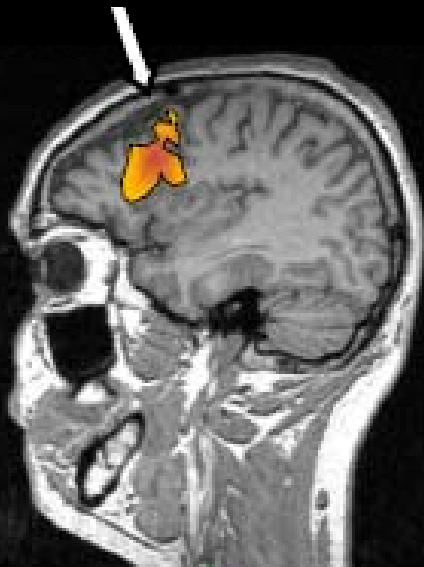
Mechanisms of chronic pain appear to be multiply determined . . .

. . . psychological factors and physiological factors

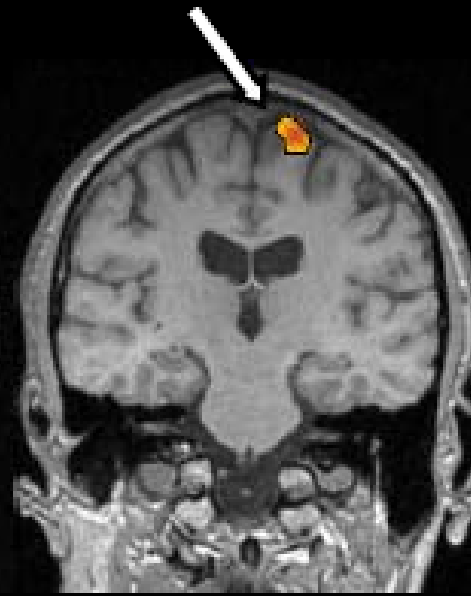
. . . likely interact with one another!

We are only now discovering the full extent of cognitive, top-down influences on physiological, bottom-up processes.

Dorsolateral prefrontal cortex



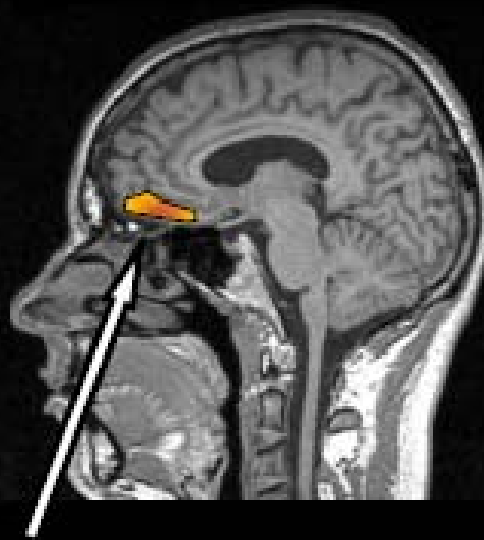
Primary somatosensor cortex



Anterior insula



Orbitofrontal cortex

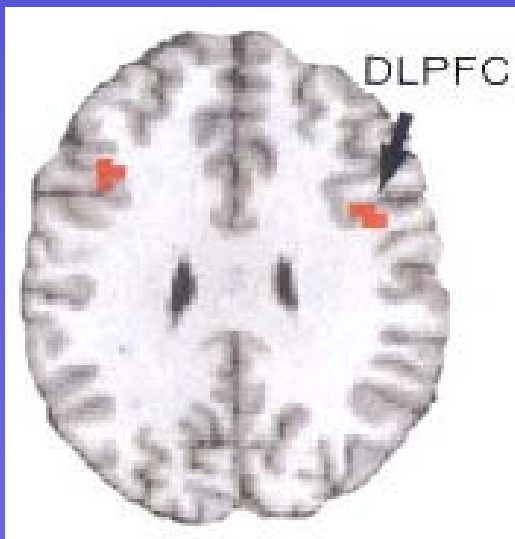


Expectations of pain will produce activation changes across various regions of the cortex, mostly involving prefrontal regions.

Placebo-Induced Changes in fMRI in the Anticipation and Experience of Pain

Tor D. Wager,^{1*†} James K. Rilling,² Edward E. Smith,¹
Alex Sokolik,³ Kenneth L. Casey,³ Richard J. Davidson,⁴
Stephen M. Kosslyn,⁵ Robert M. Rose,⁶ Jonathan D. Cohen^{2,7}

20 FEBRUARY 2004 VOL 303 SCIENCE www.sciencemag.org

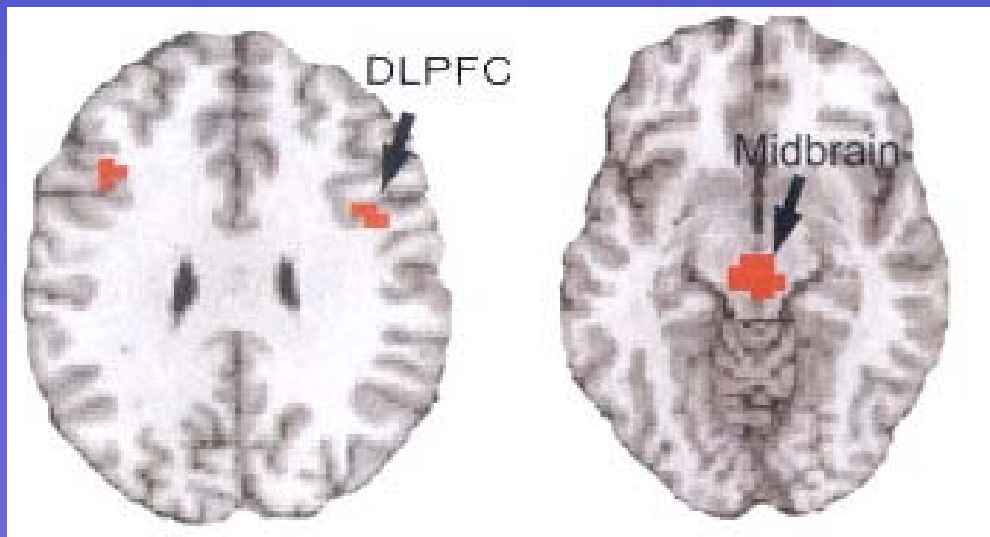


In anticipation of pain relief, there is increased activity across the DLPFC

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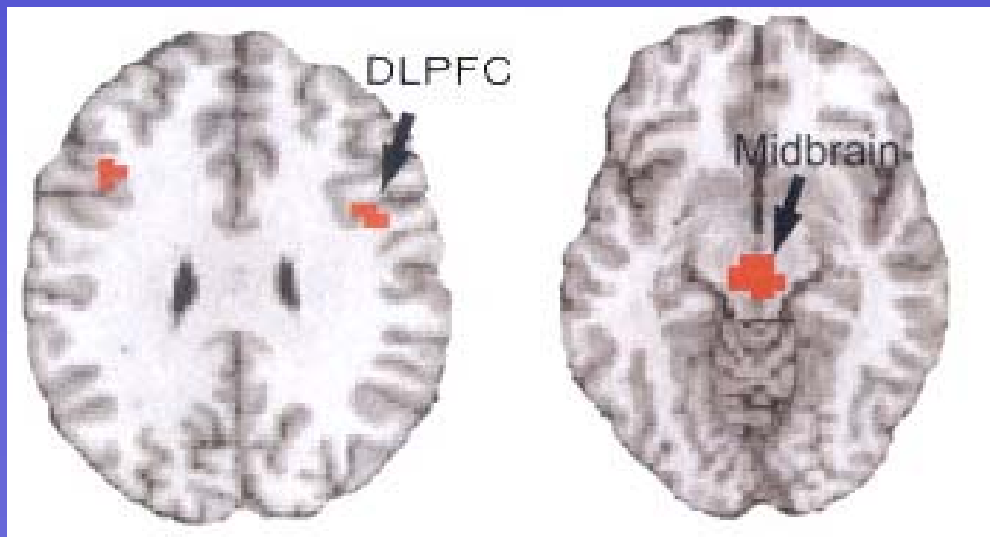
Within specific brainstem
regions

Same regions where
descending, inhibitory
opioid-rich cells can be
found

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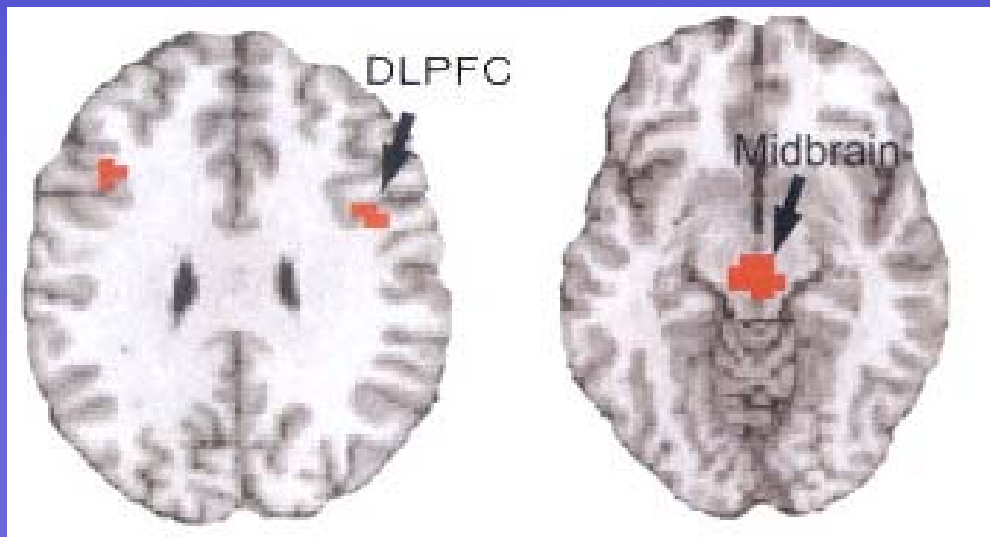
The brain mobilizes prefrontal structures involved in the mental representation of pain or pain relief

Solicits the help of opioidergic brainstem nuclei to induce systemic analgesic responses.

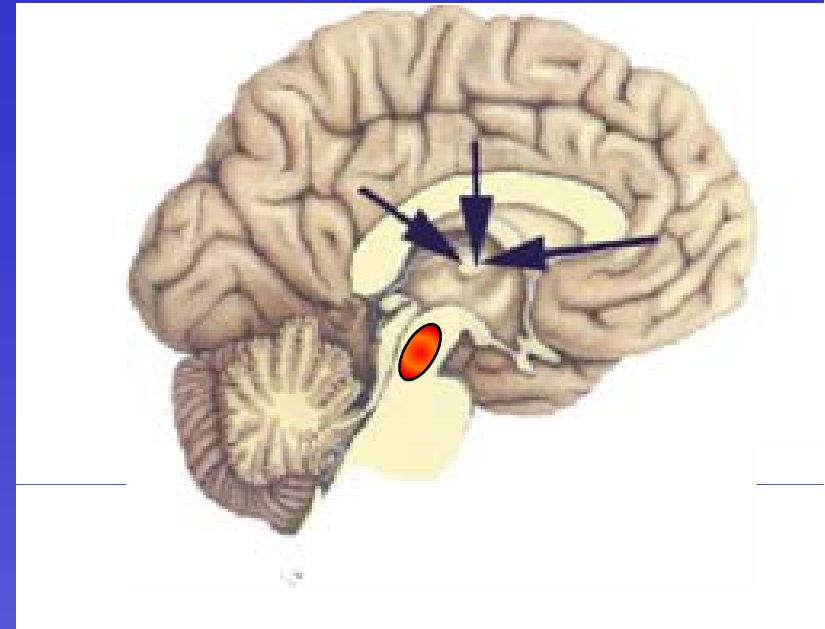
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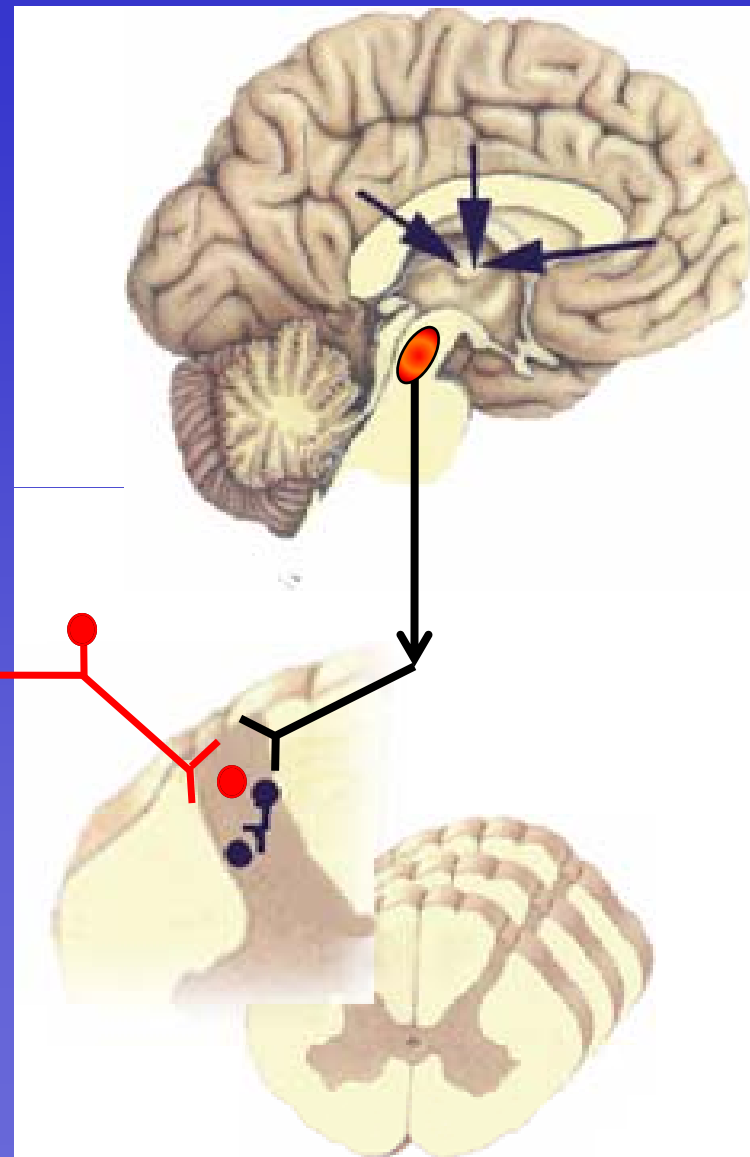
No proof that
expectations (placebo)
actually influence the
strength of descending
inhibitory systems



Change in brainstem activity = change the strength of descending inhibition

= a change in the way nociceptive information is processed in the spine

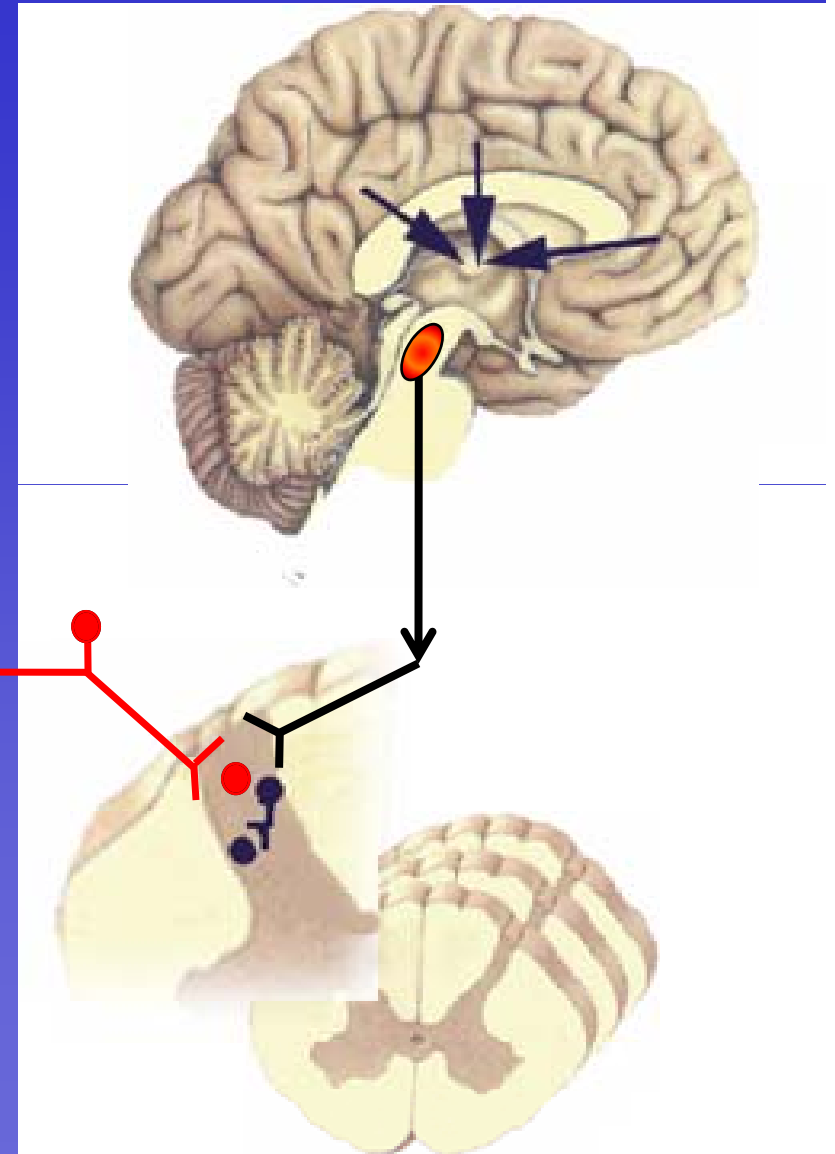
To know if expectations affect the strength of descending inhibitory systems . . .



**Trigger
descending inhibition**

**measure participant
expectations**

**record spinal nociceptive
processing**





Pain 130 (2007) 137–143

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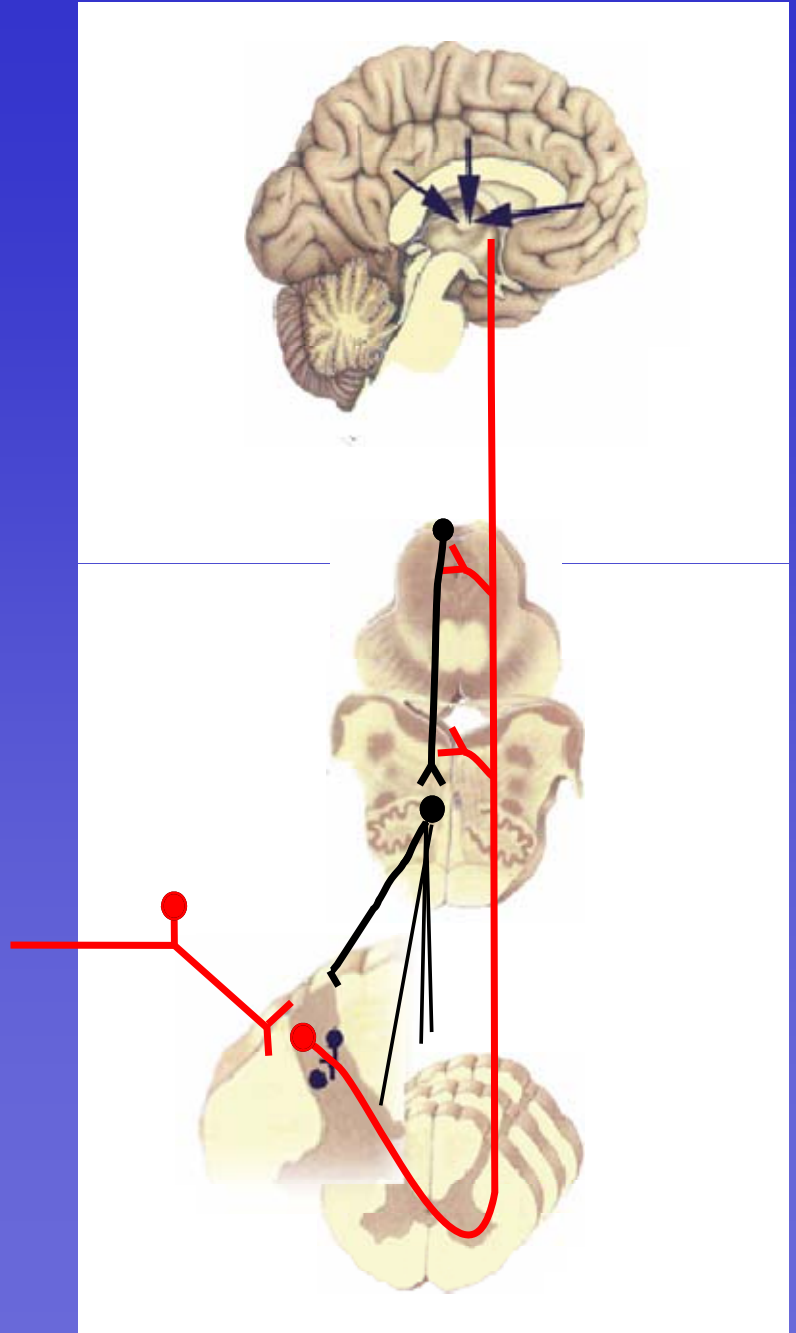
Descending analgesia – When the spine echoes what the brain expects

Philippe Goffaux ^a, William John Redmond ^a, Pierre Rainville ^b, Serge Marchand ^{a,*}

^a *Université de Sherbrooke, Faculté de Médecine, Sherbrooke, Que., Canada J1H 5N4*

^b *Université de Montréal, Faculté de Médecine Dentaire, Montréal, Que., Canada H3C 3J7*

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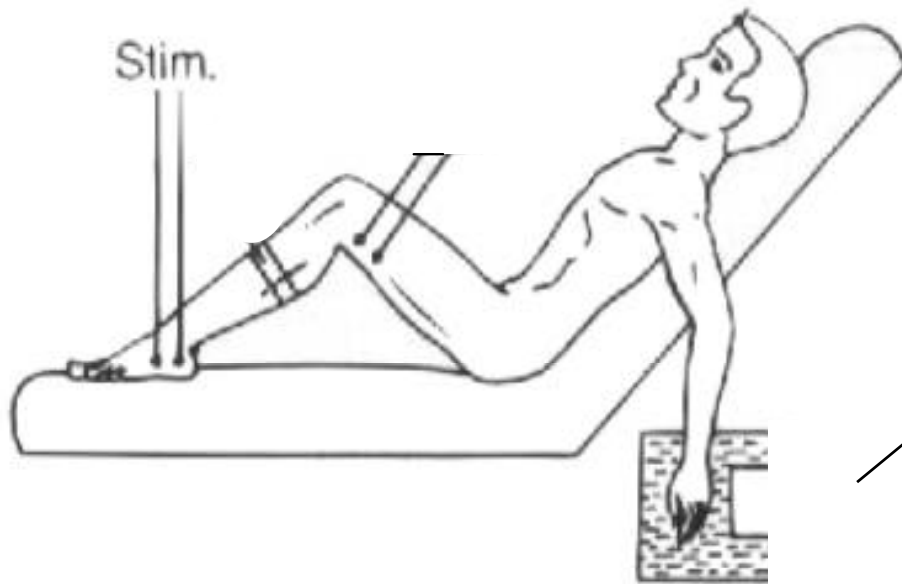
Methods & Participants



2 Groups:

1. Bath water= Analgesic (N=10)
2. Bath water = Hyperalgesic (N=10)

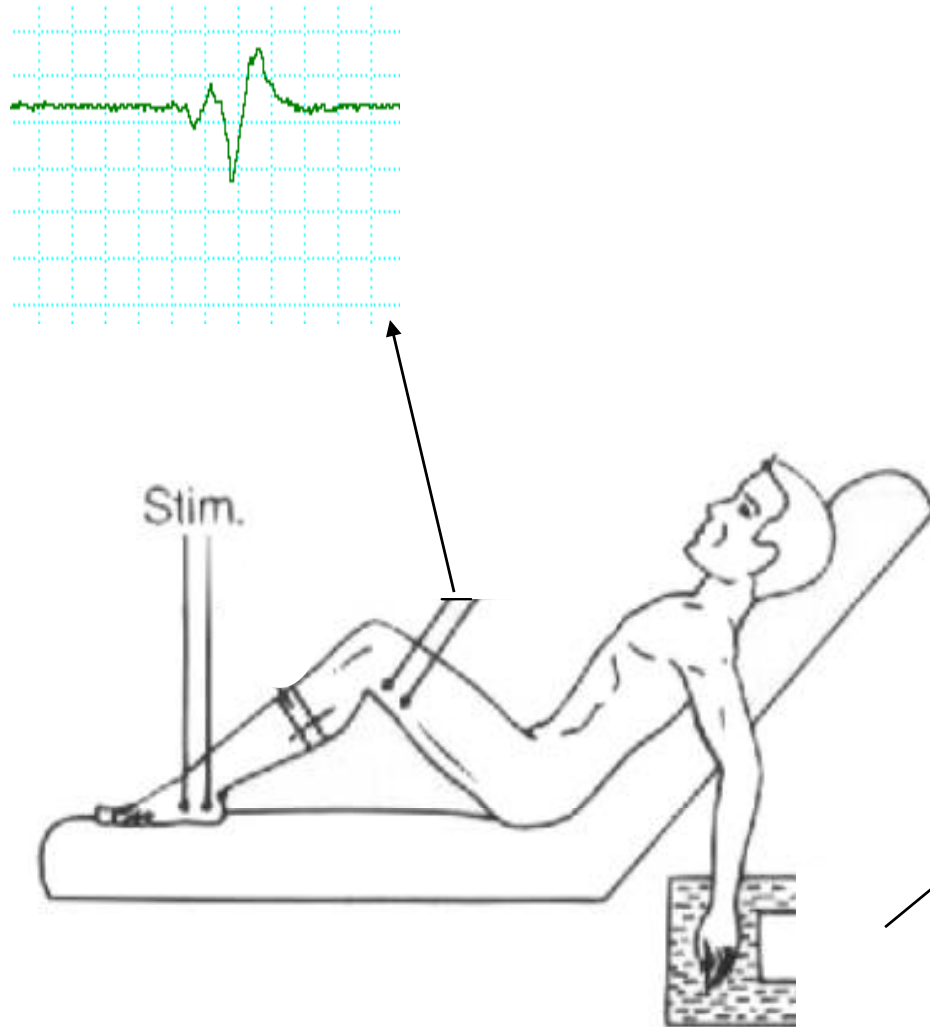
Methods & Participants



2 Groups:

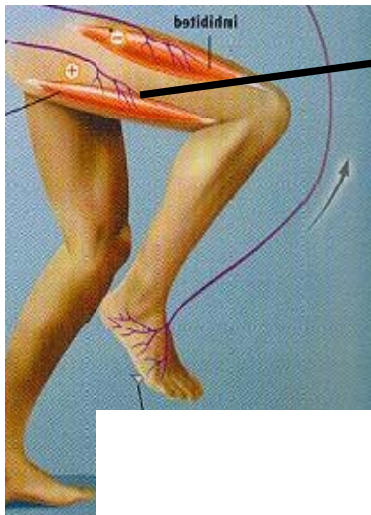
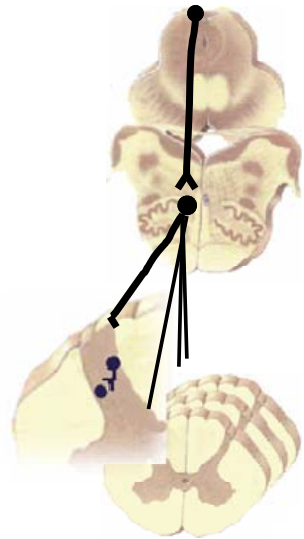
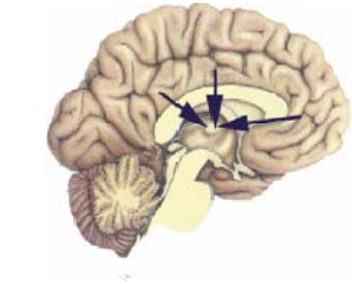
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2. Bath water = Hyperalgesic (N=10)

Methods & Participants

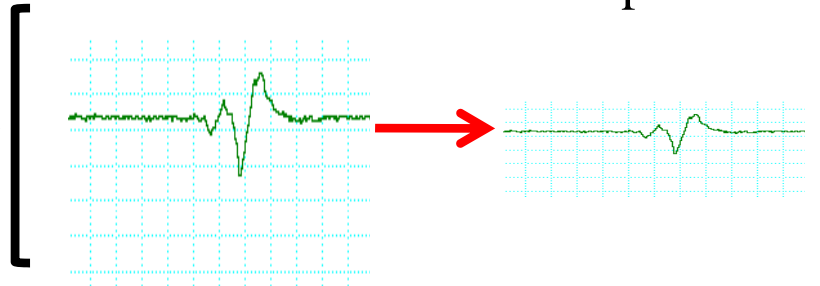


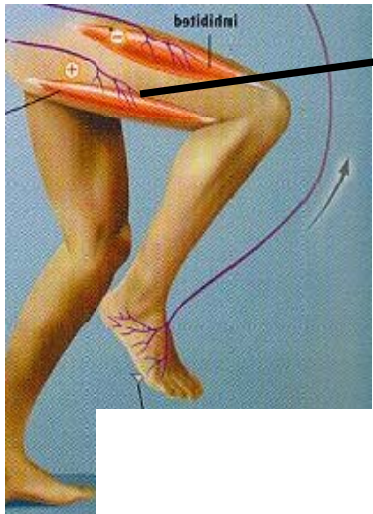
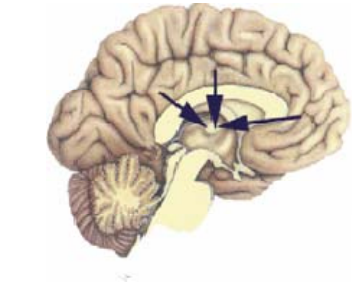
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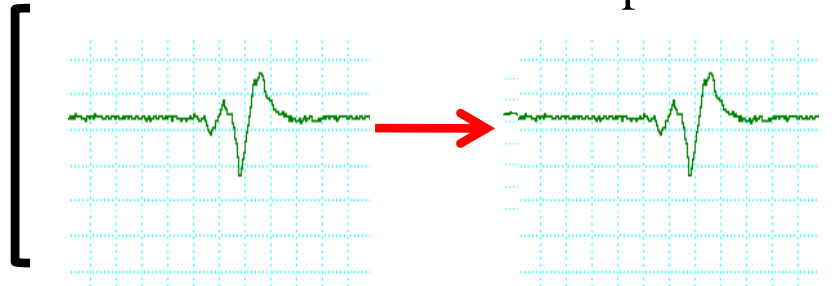


Nociceptive Withdrawal Reflex Response

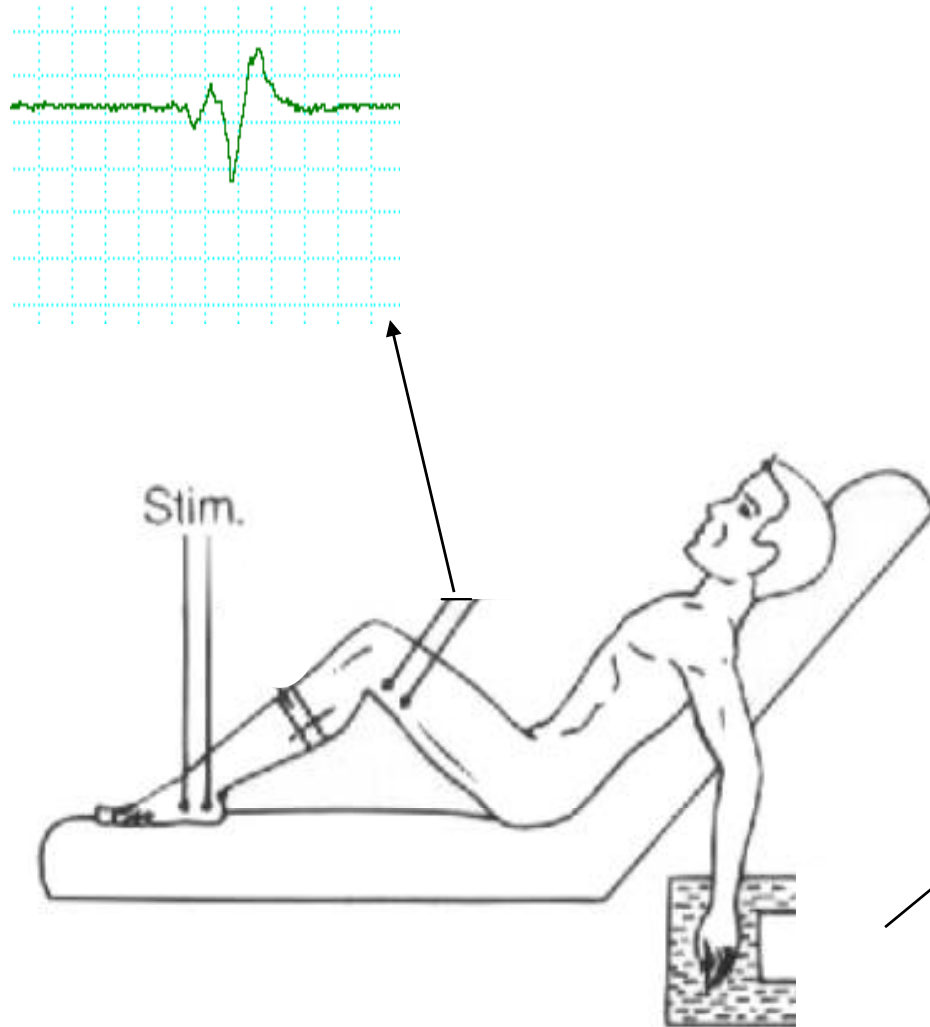




Nociceptive Withdrawal Reflex Response



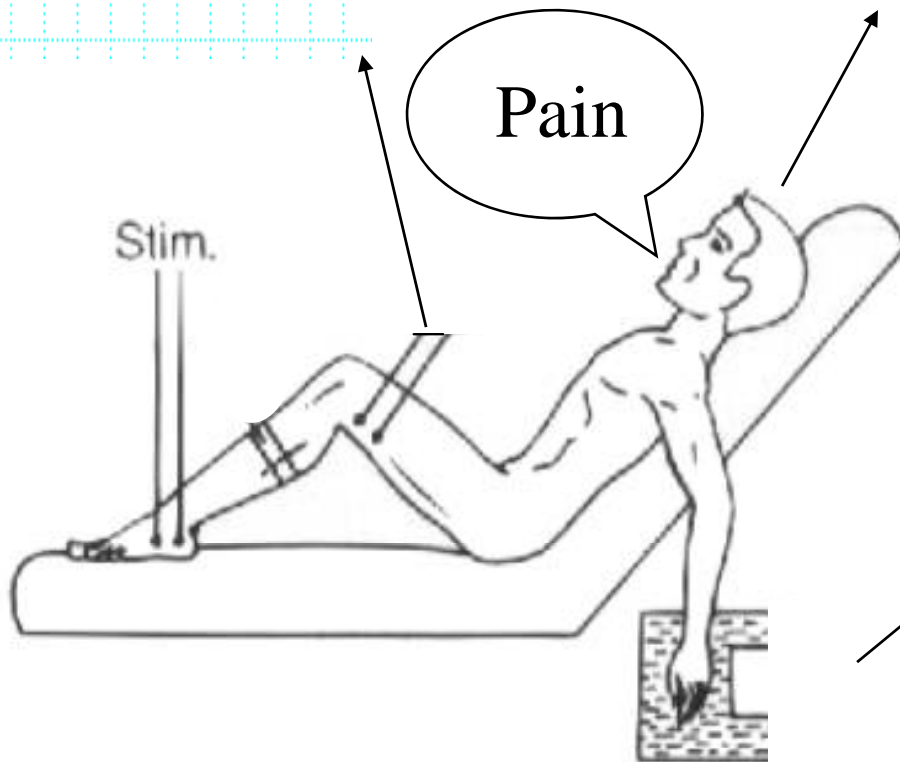
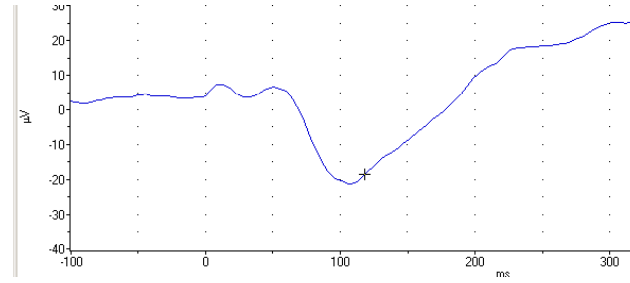
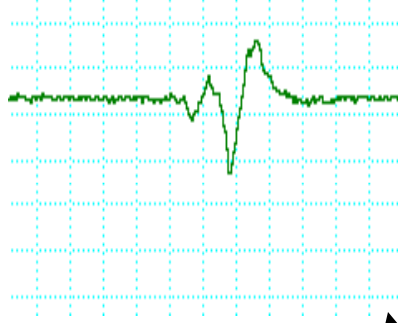
Methods & Participants



2 Groups:

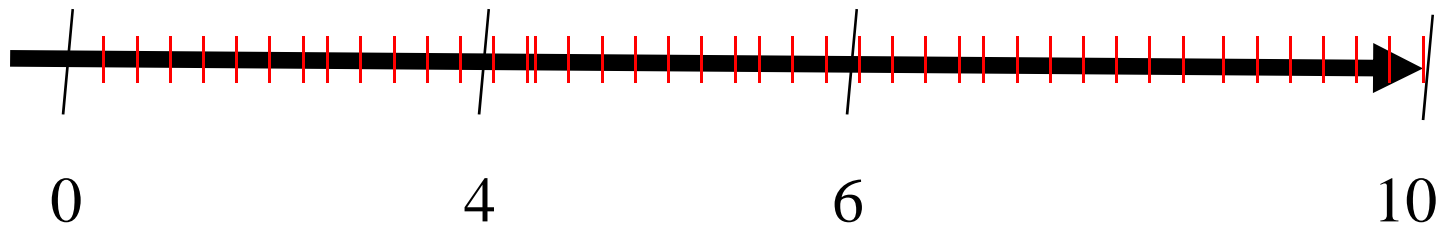
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Methods & Participants



2 Groups:

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Time (min.)

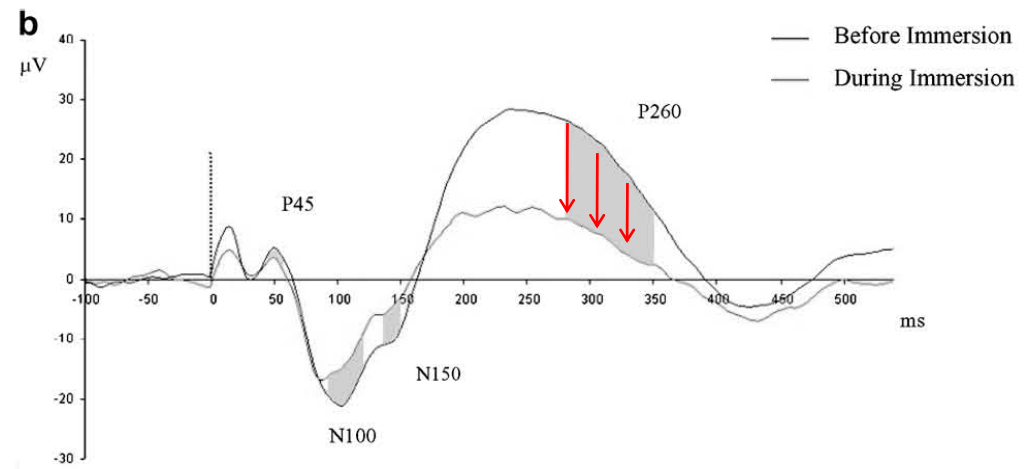
Analgesia
Expected

77% Decrease in Pain

Hyperalgesia
Expected

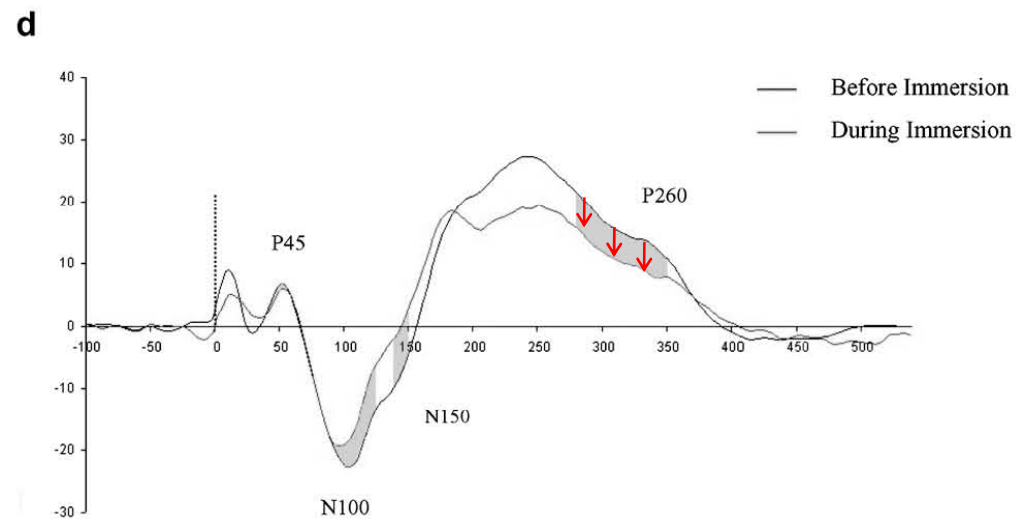
0% Decrease in Pain

Analgesia
Expected



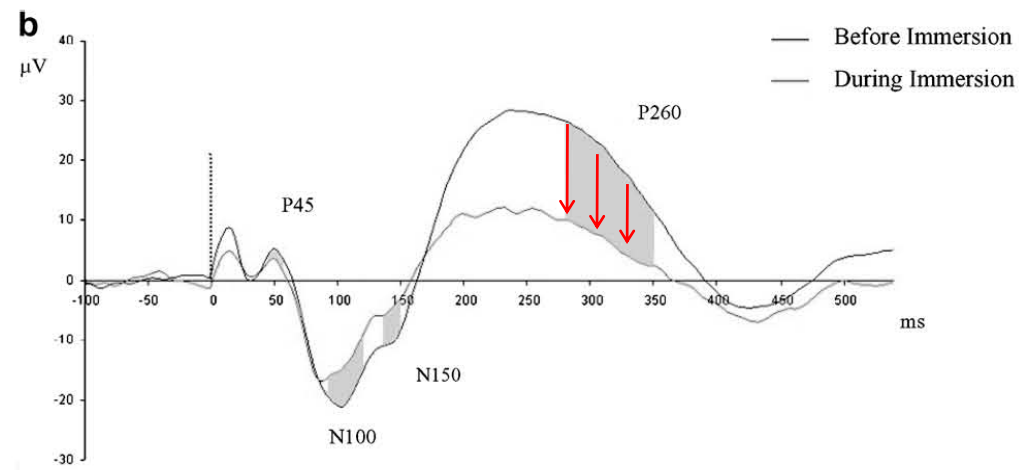
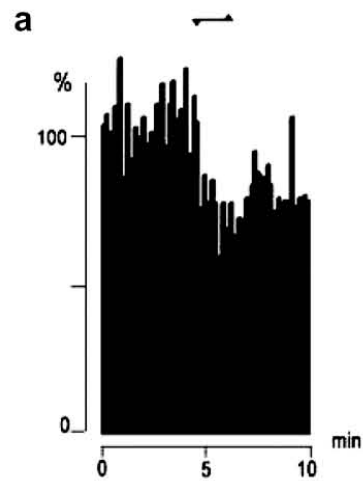
77% Decrease in Pain

Hyperalgesia
Expected



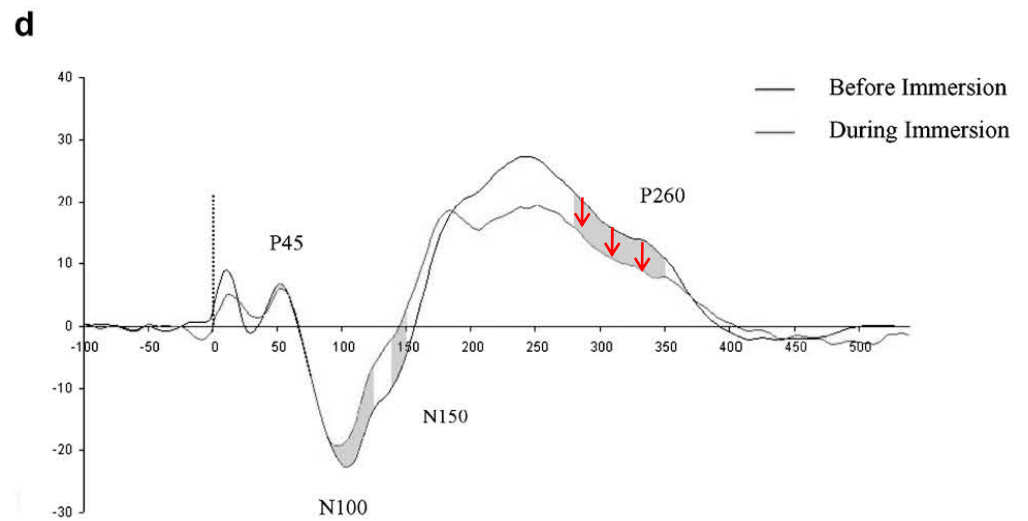
0% Decrease in Pain

Analgesia
Expected



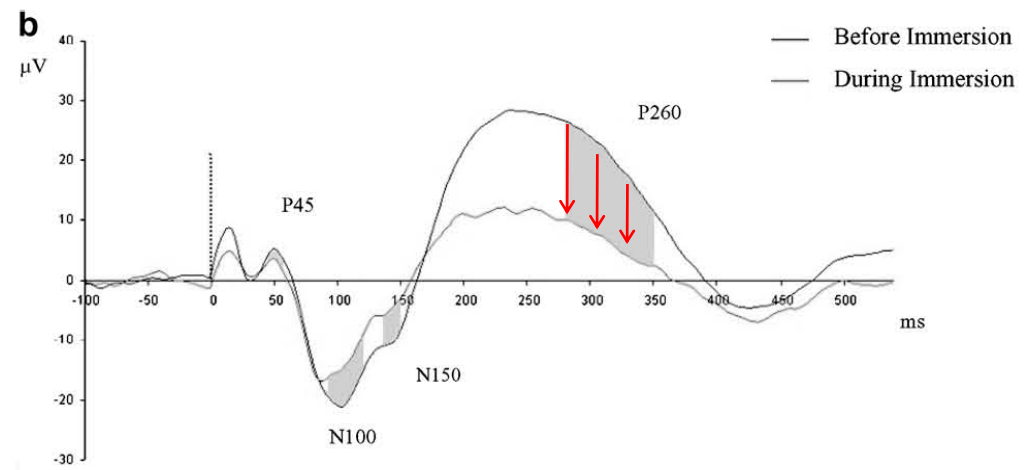
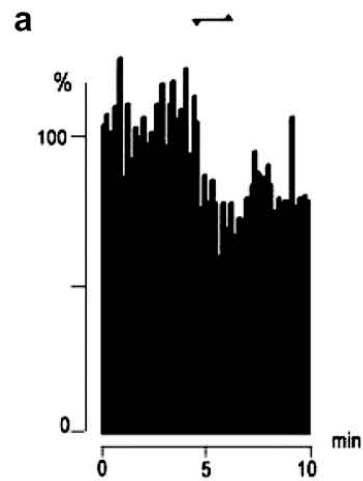
77% Decrease in Pain

Hyperalgesia
Expected



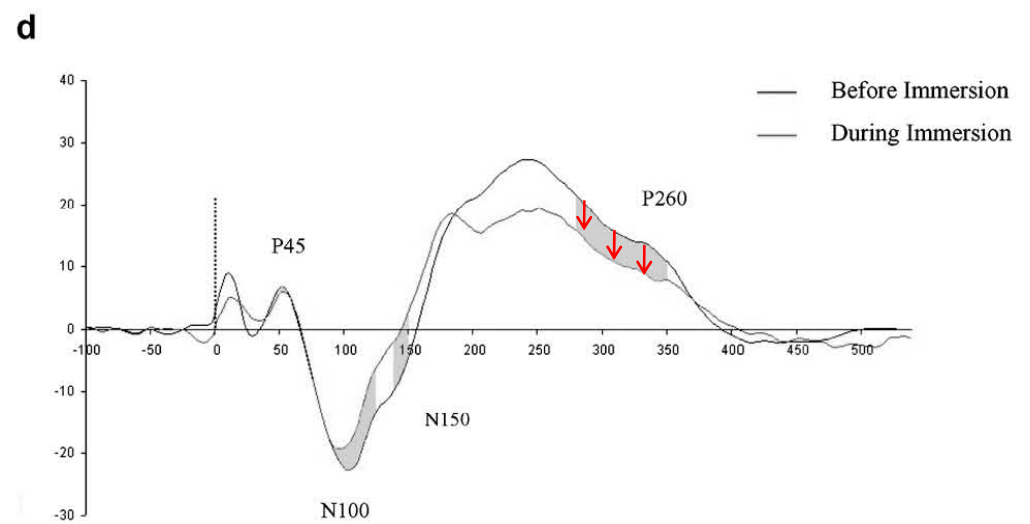
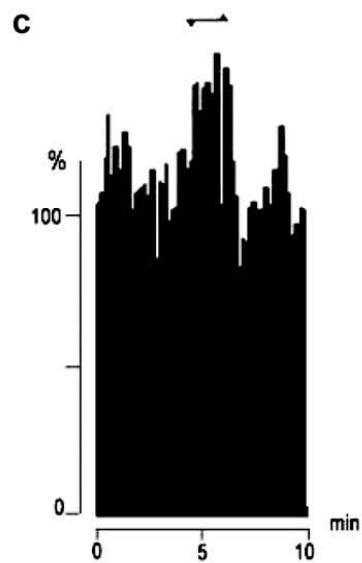
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Analgesia
Expected



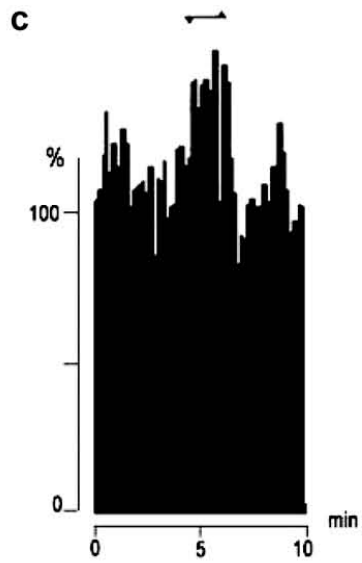
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Hyperalgesia
Expected

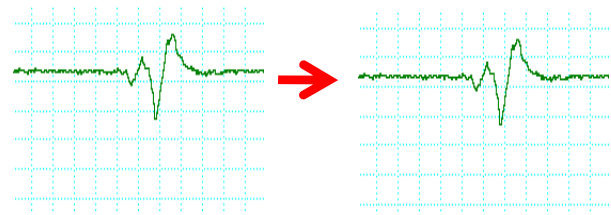
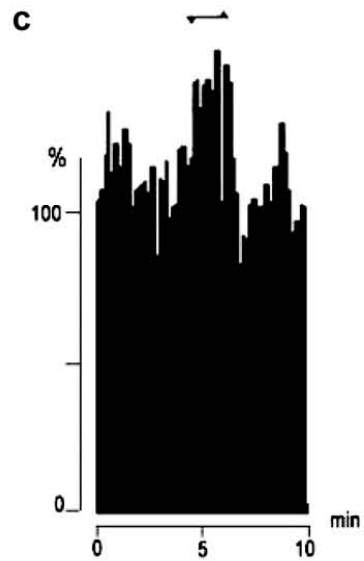


0% Decrease in Pain

Hyperalgesia
Expected



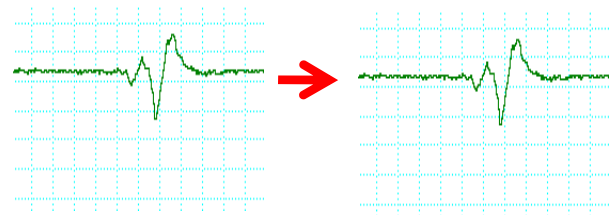
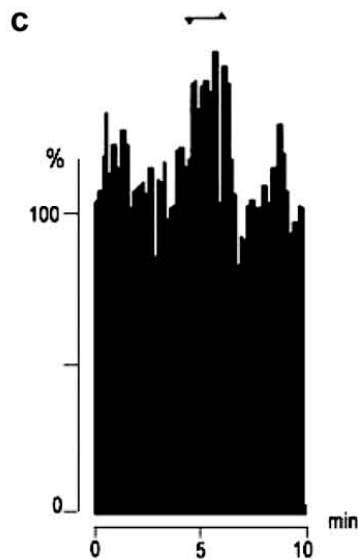
Hyperalgesia
Expected



Confirms that expectations affect the strength of descending inhibitory responses and modulate cortical and spinal responses in a way that is consistent with what is anticipated.



Hyperalgesia
Expected



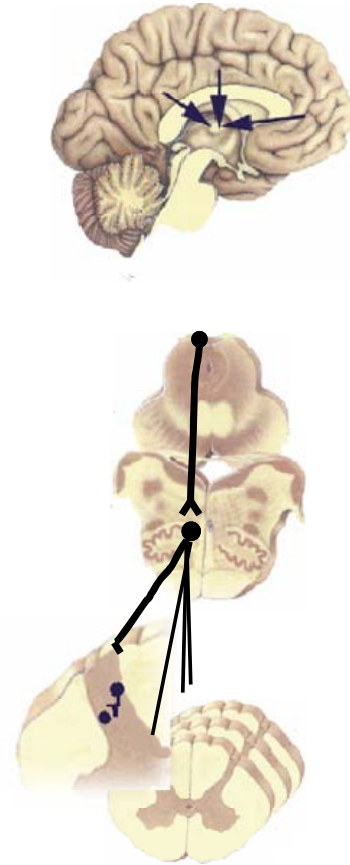
Fibromyalgia



Fibromyalgia



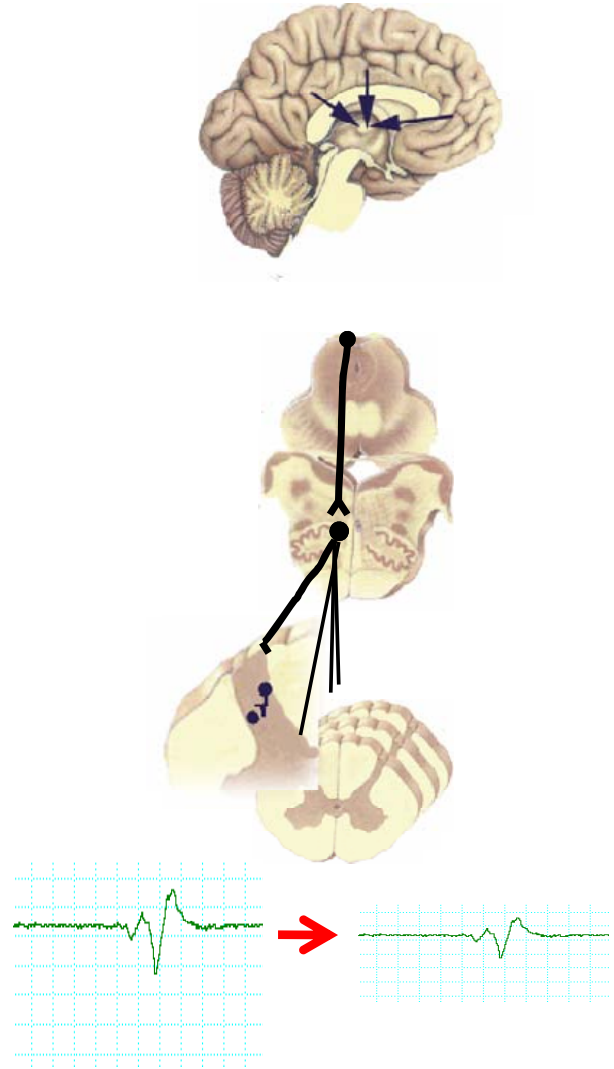
Fibromyalgia With expectations of pain relief



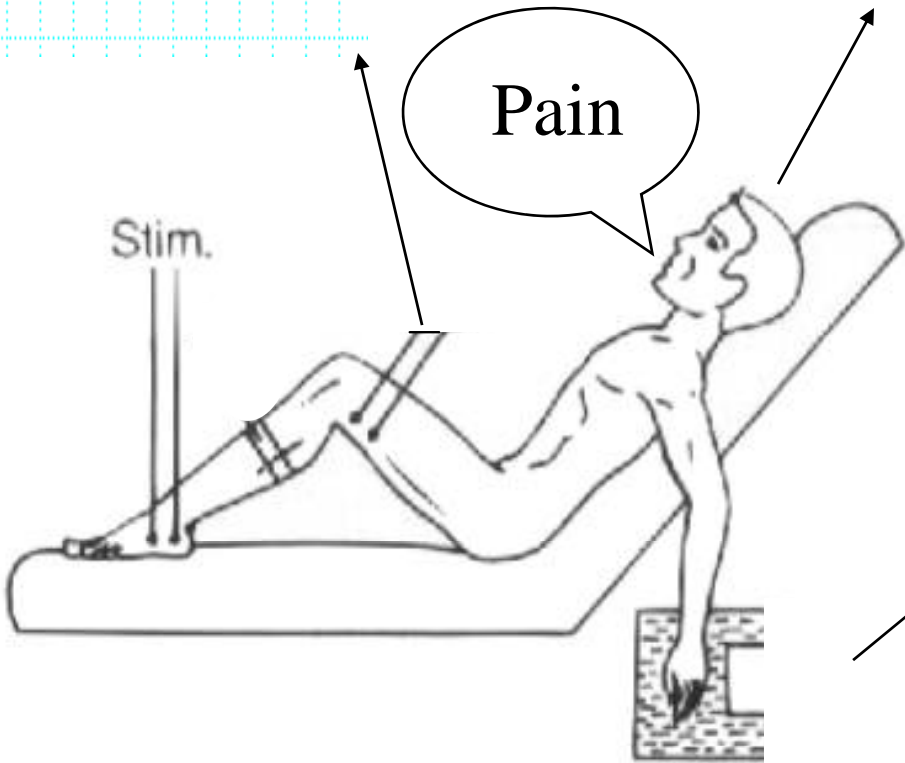
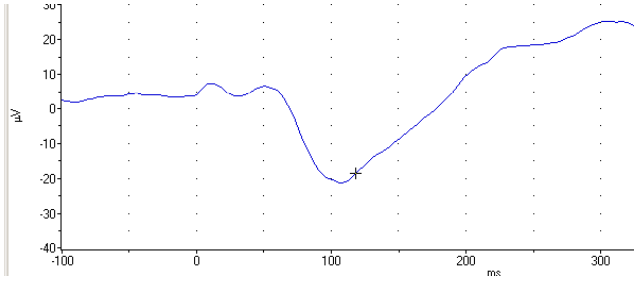
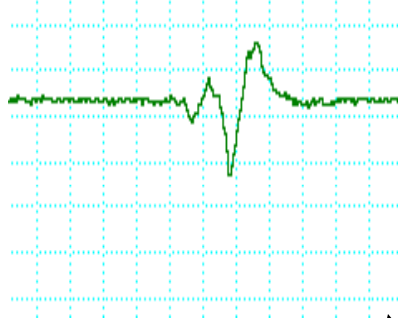
Fibromyalgia



Fibromyalgia With expectations of pain relief

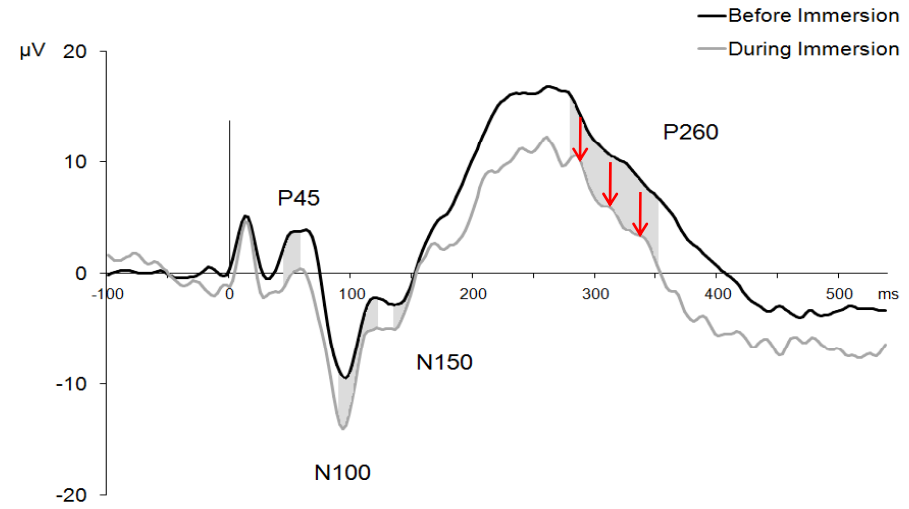


Methods & Participants



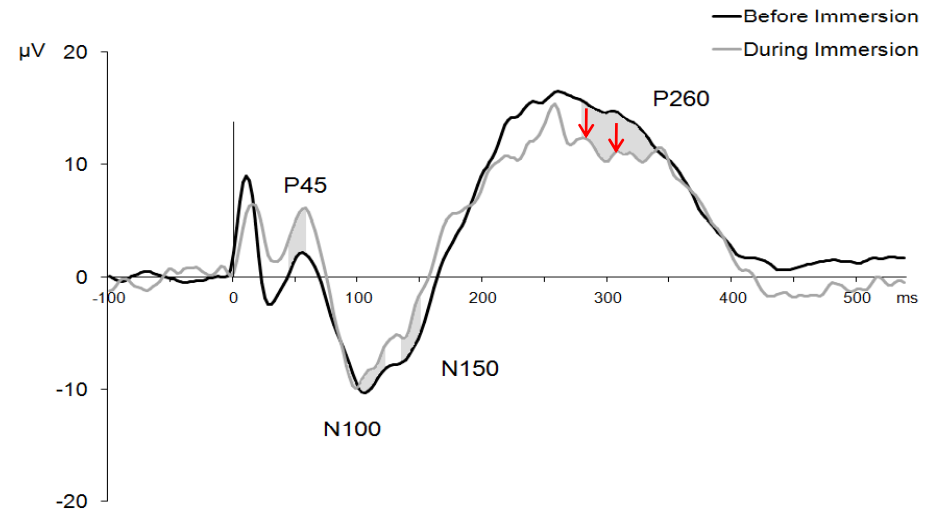
- 2 Groups:**
- 1. Bath water= Analgesic (N=7)
 - 2. Bath water = Hyperalgesic (N=7)

Analgesia Expected



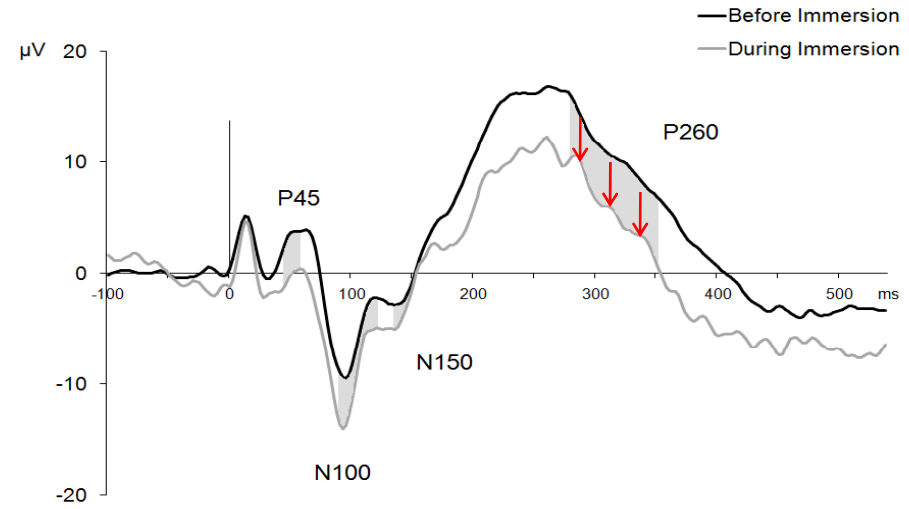
24% Decrease in Pain

Hyperalgesia Expected



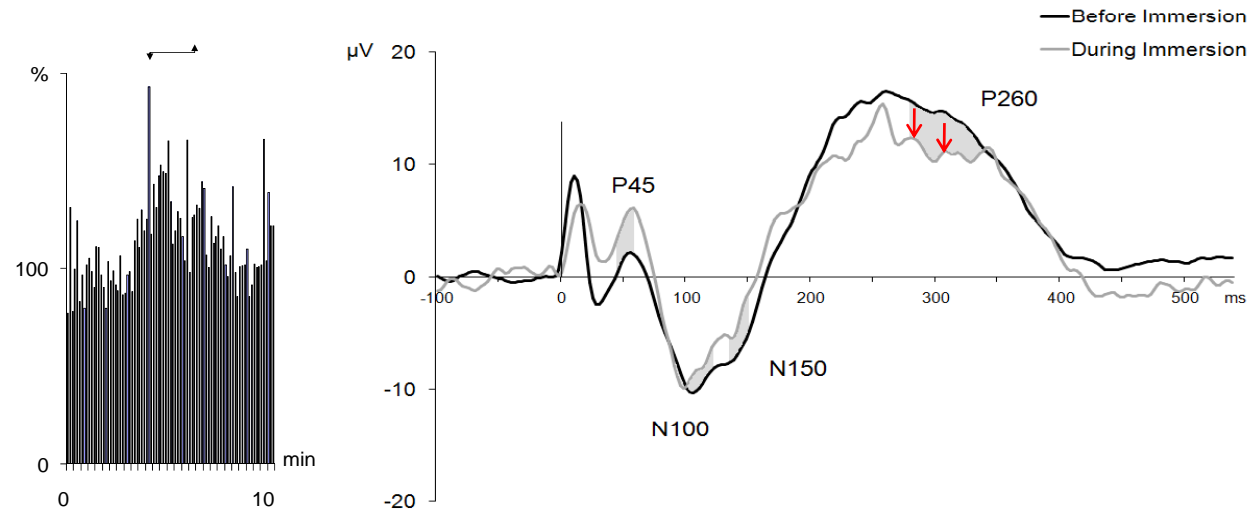
20% Increase in Pain

Analgesia Expected



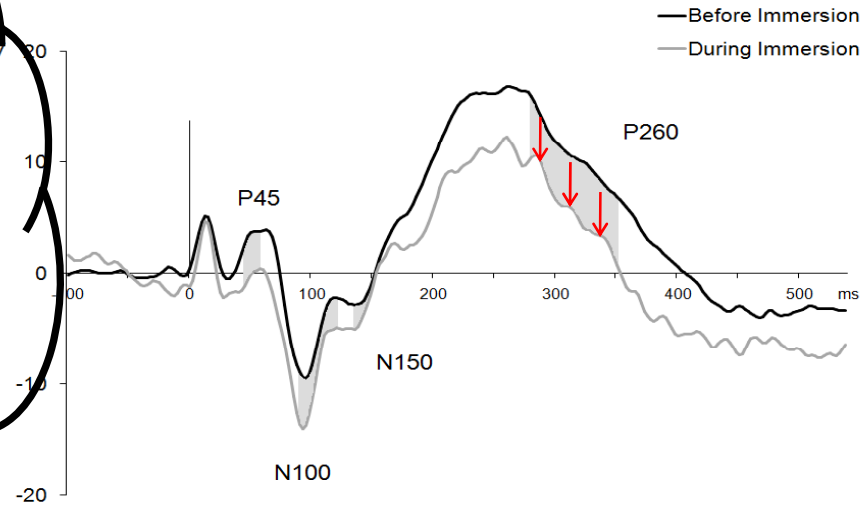
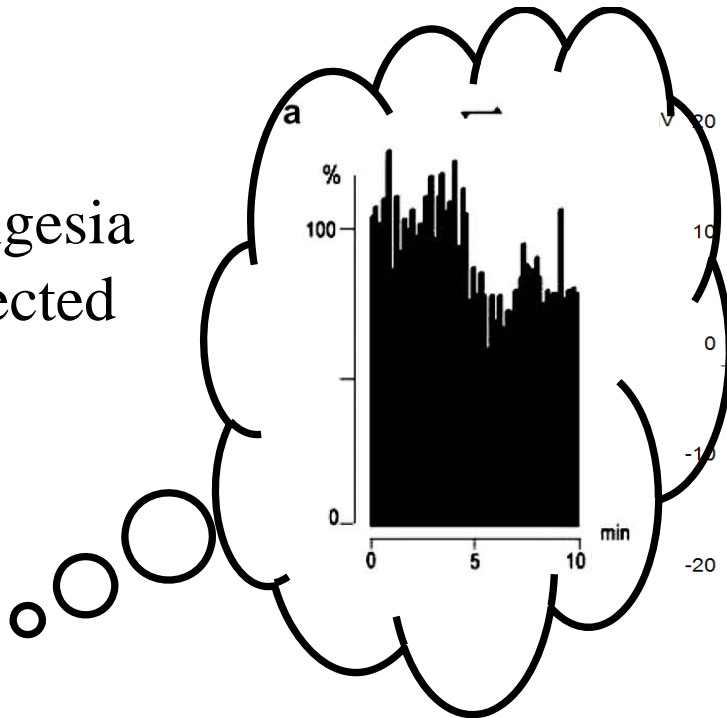
24% Decrease in Pain

Hyperalgesia Expected



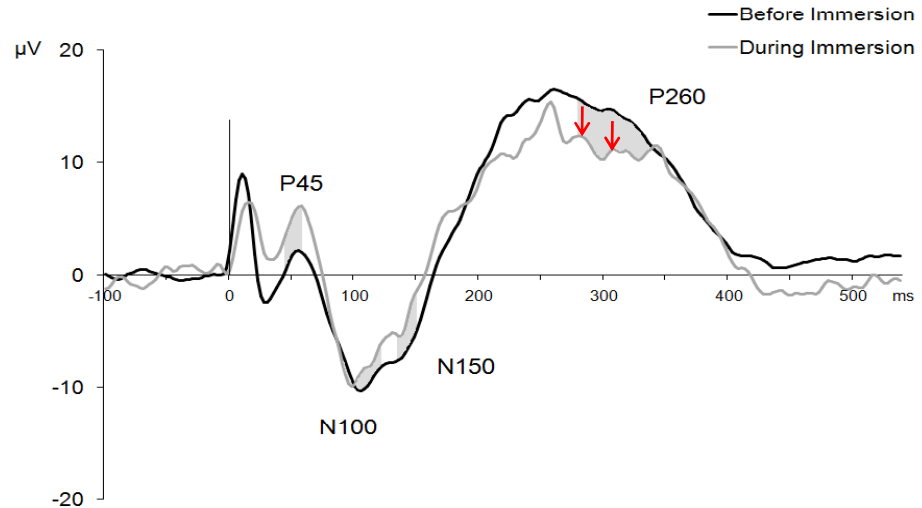
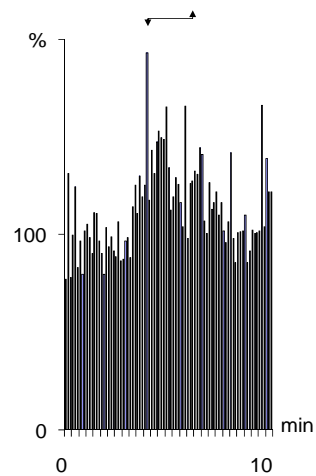
20% Increase in Pain

Analgesia
Expected



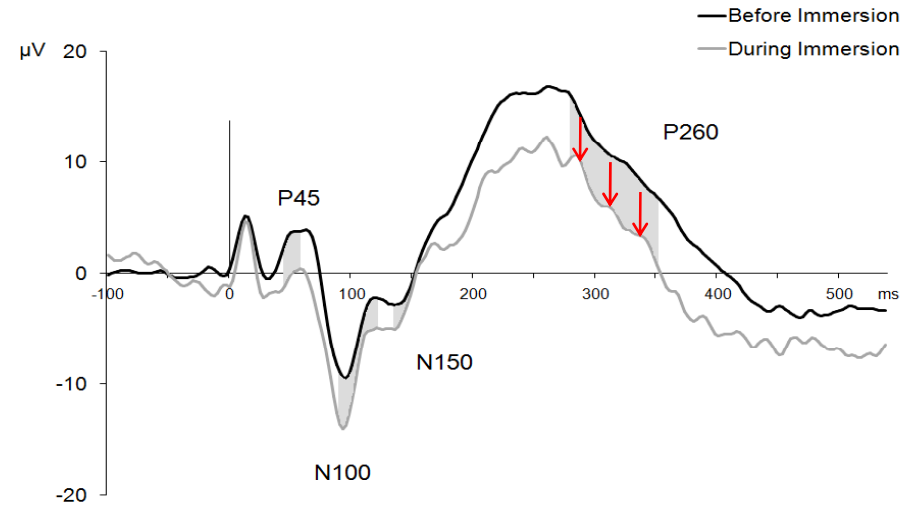
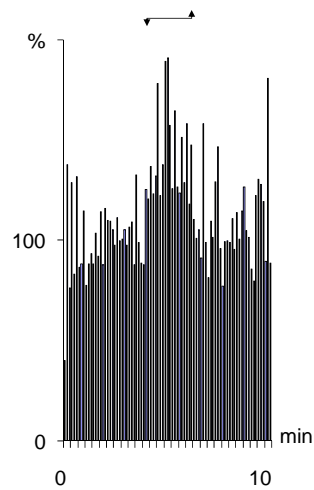
24% Decrease in Pain

Hyperalgesia
Expected



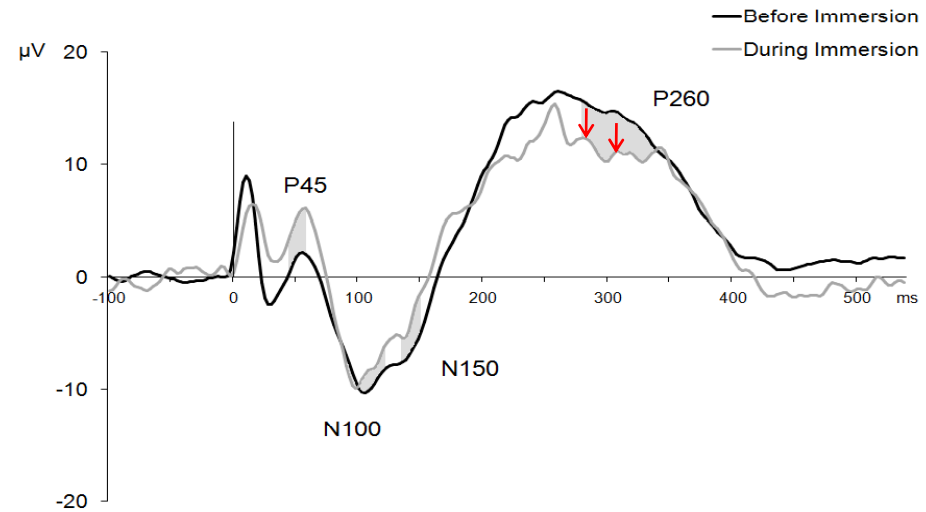
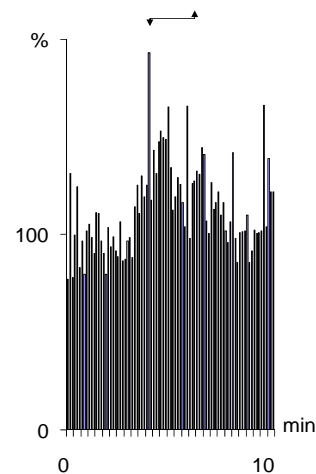
20% Increase in Pain

Analgesia Expected



24% Decrease in Pain

Hyperalgesia Expected



20% Increase in Pain

Conclusion:

These results indicate that FMs are capable of expectancy-induced analgesia but that, unlike healthy subjects, this does not depend on the recruitment of descending inhibitory projections.

In fact, even when FM expect and experience analgesia, their spine continues to show hyperalgesic responses.