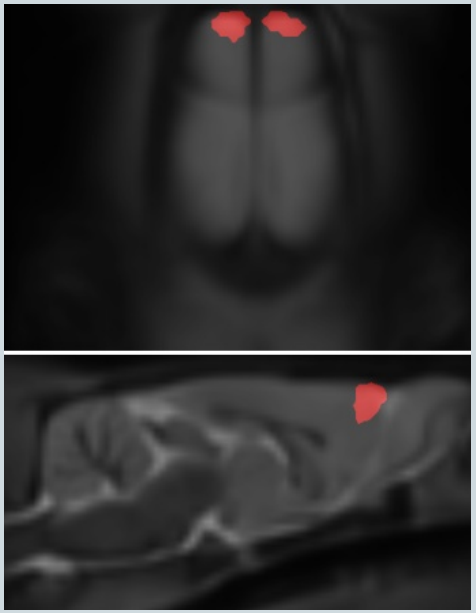
Impact of chronic pain on the rodent brain

M. Catherine Bushnell

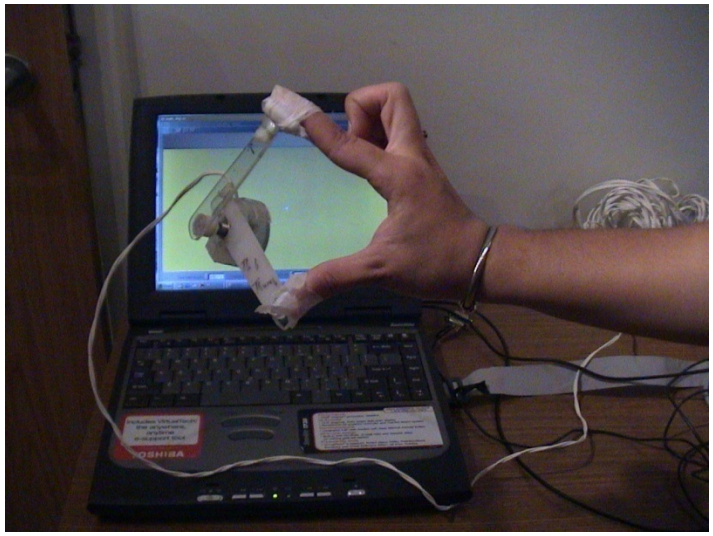
National Center for Complementary
and Alternative Medicine, NIH



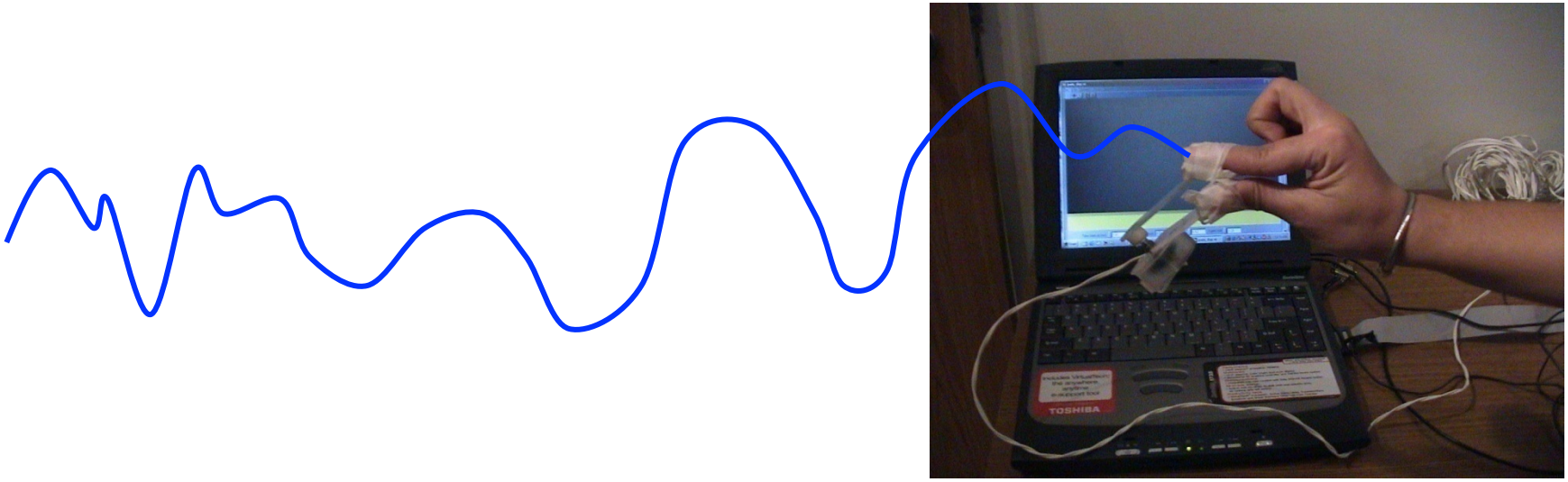
Disclaimer

I am presenting today's teaching in my own personal professional capacity. Any views presented are mine and do not reflect the position or policy of the National Institutes of Health, the Public Health Service, or the US Department of Health and Human Services.

Human chronic pain conditions characterized by ongoing pain



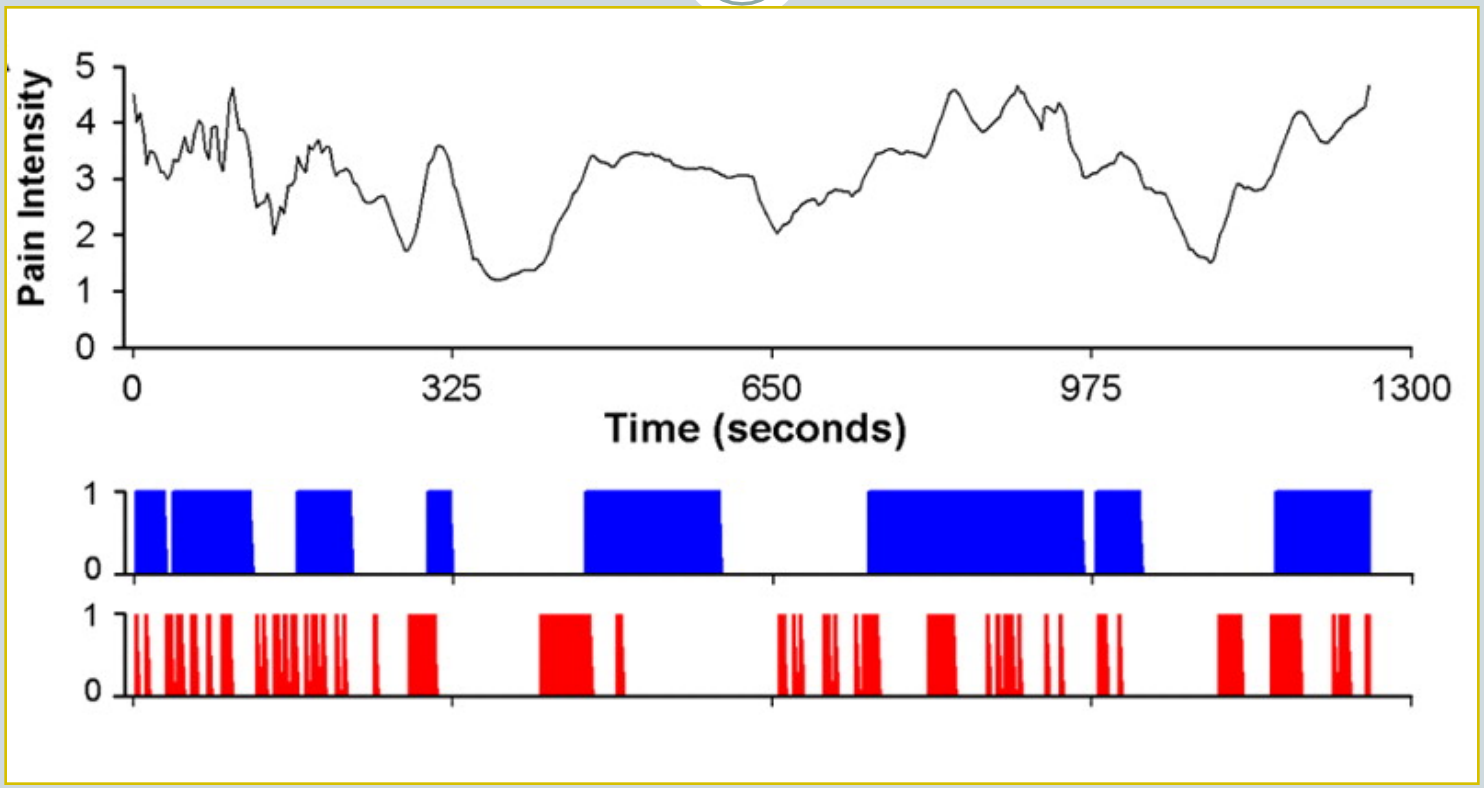
Pain intensity = 10/10



Pain intensity = 0/10

MRI: Magnetic resonance imaging.
Baliki MN, et al. *J Neurosci*. 2006;21:12165–12173.

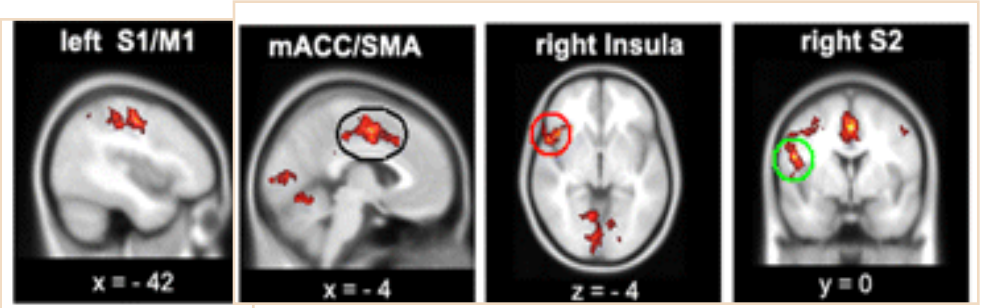
Chronic back pain has transient and sustained components



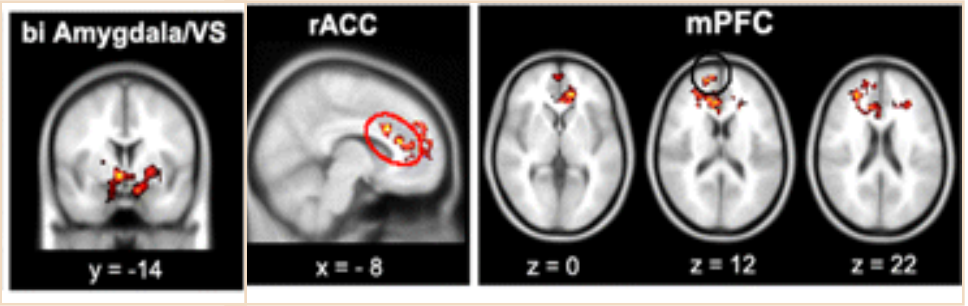
Baliki MN, et al. *J Neurosci*. 2006;21:12165–12173.

Seeing ongoing pain in human chronic pain patients

Correlates of increasing pain are similar to acute pain processing



Correlates of high sustained pain involve emotional and cognitive regions



Baliki MN, et al. *J Neurosci*. 2006;21:12165–12173.

Seeing ongoing pain in rodents

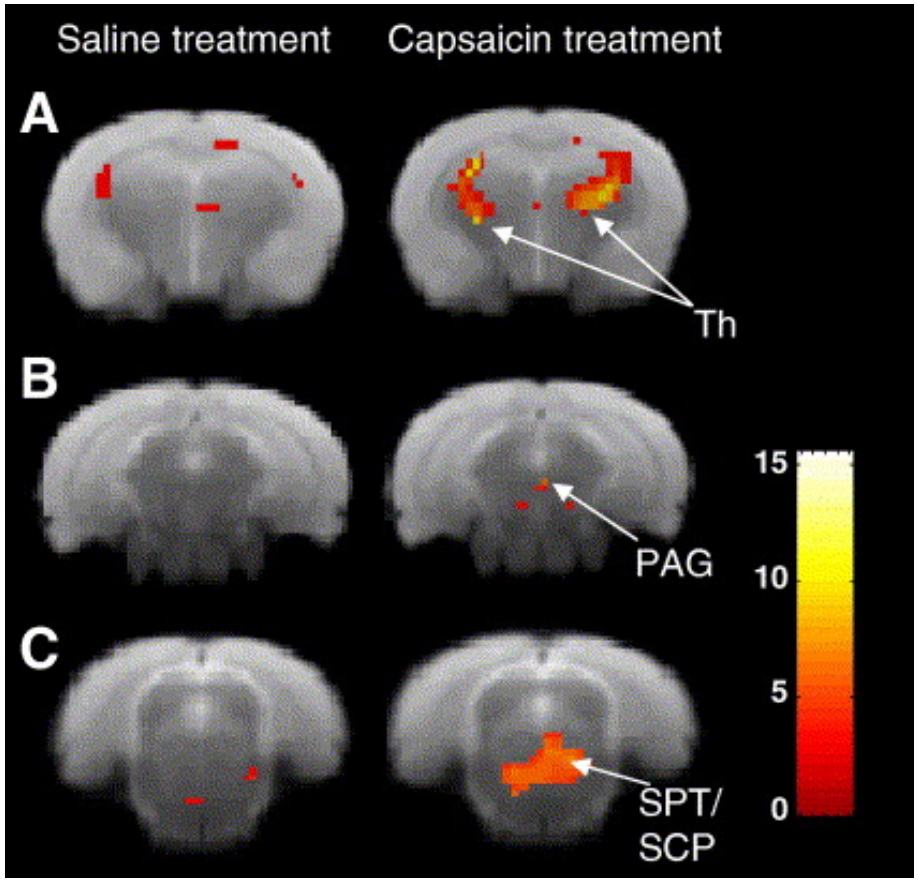
Small Animal MRI

Pitfalls of animal MRI =

Must either anesthetize or restrain animal

Cannot correlate activity with perception

fMRI under anesthesia can reveal strong nociceptive activation



Intradermal capsaisin injection in rat (isoflurane)

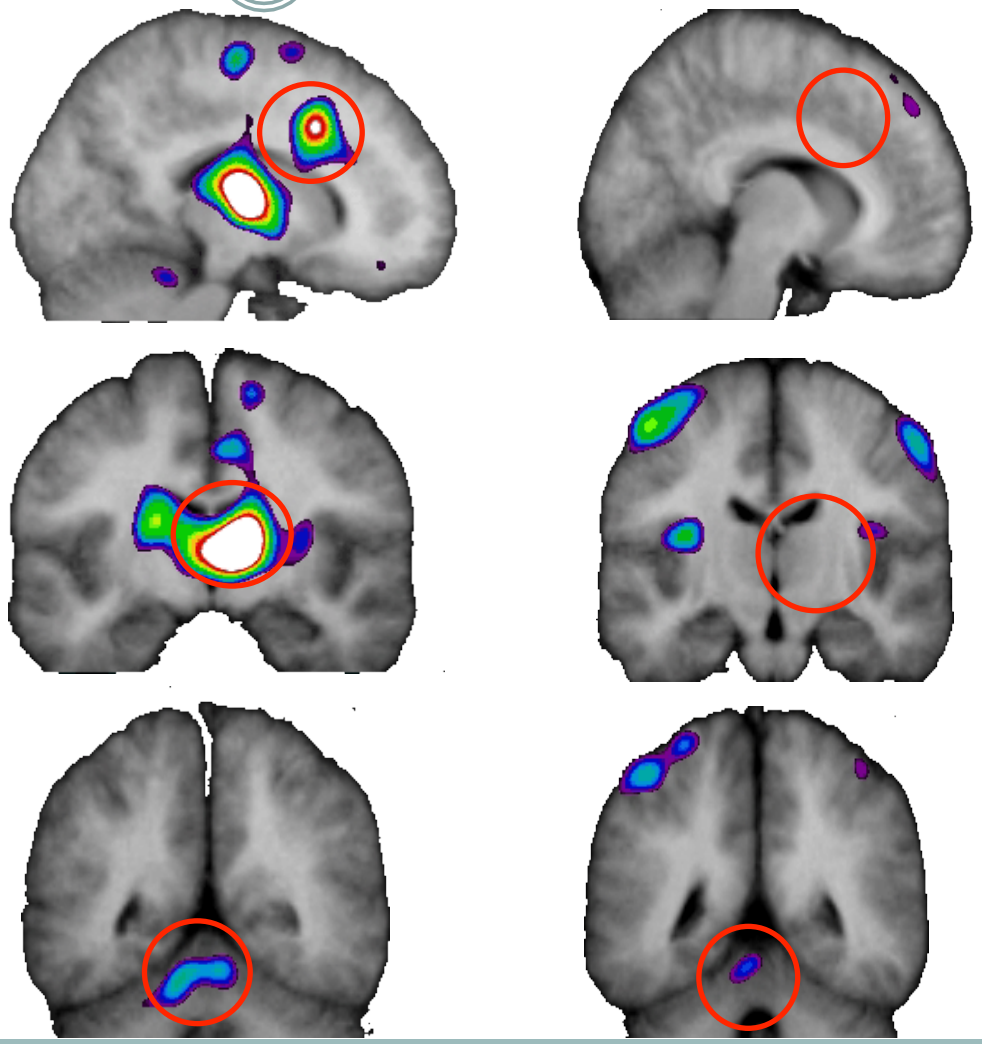
Governo et al 2006

Anesthesia alters pain-evoked activation

ACC

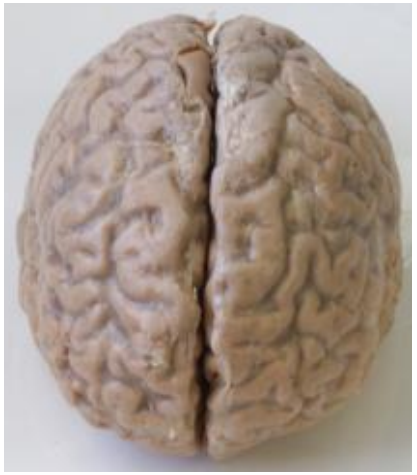
Thalamus

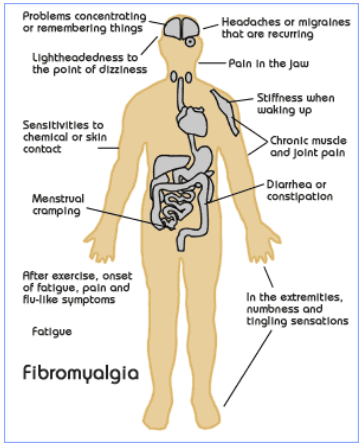
Cerebellum



Hofbauer et al 2004

Reduced gray matter in many chronic pain conditions





Fibromyalgia

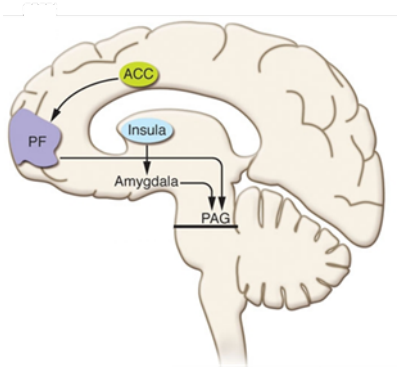
Irritable bowel syndrome

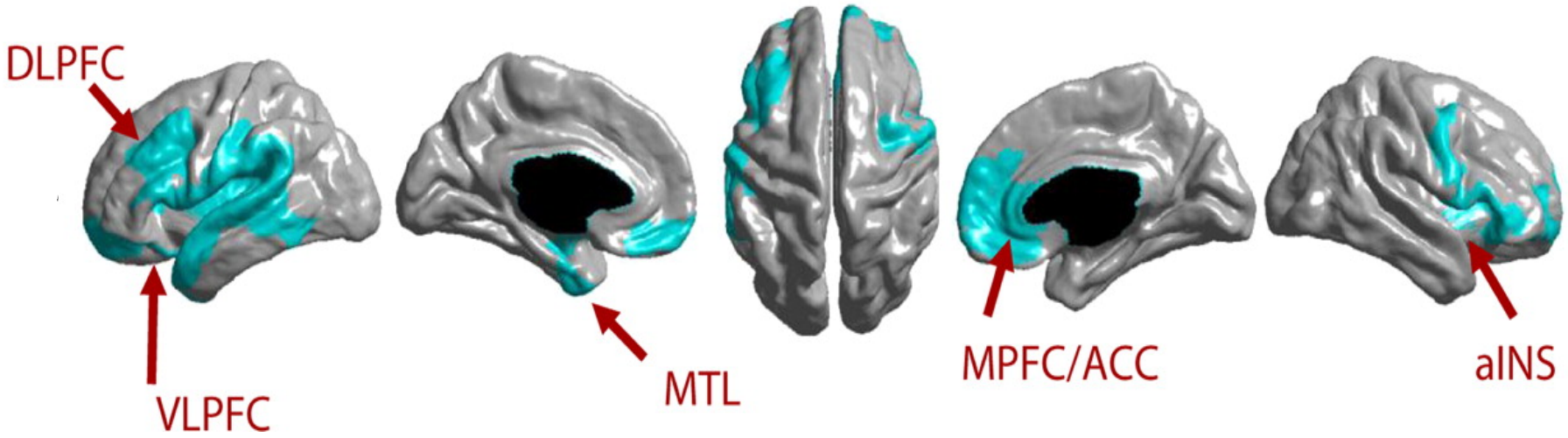
Back pain

Headache

Tracey and Bushnell J. Pain 2008 (review)

Cortical thickness decreases mainly in frontal lobes



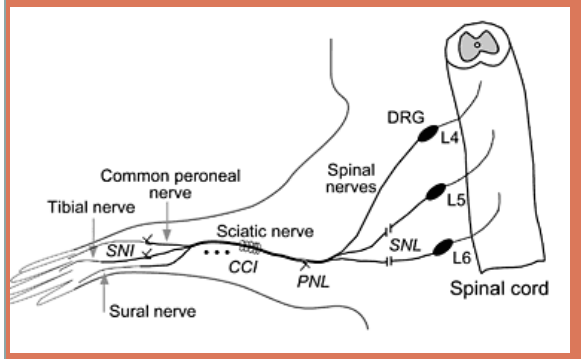


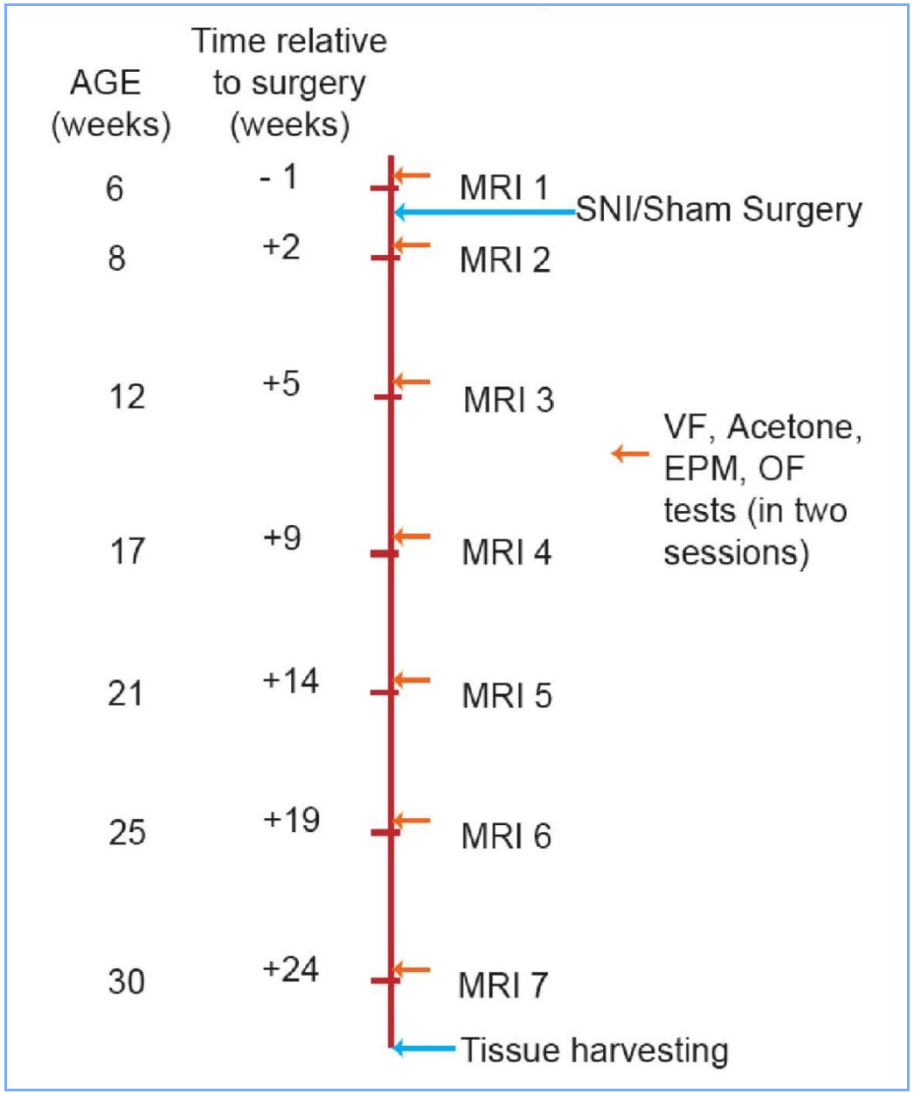
Seminowicz D A et al. J. Neurosci. 2011.

Back translate to rat model of neuropathic pain

Seminowicz DA et al. Neuroimage, 2009.

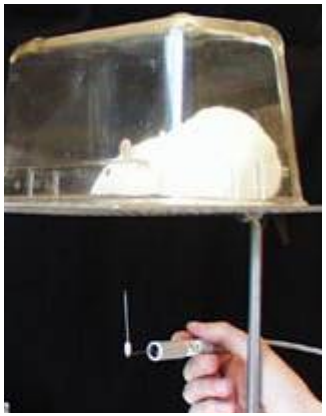
Neuropathic rats followed for five months

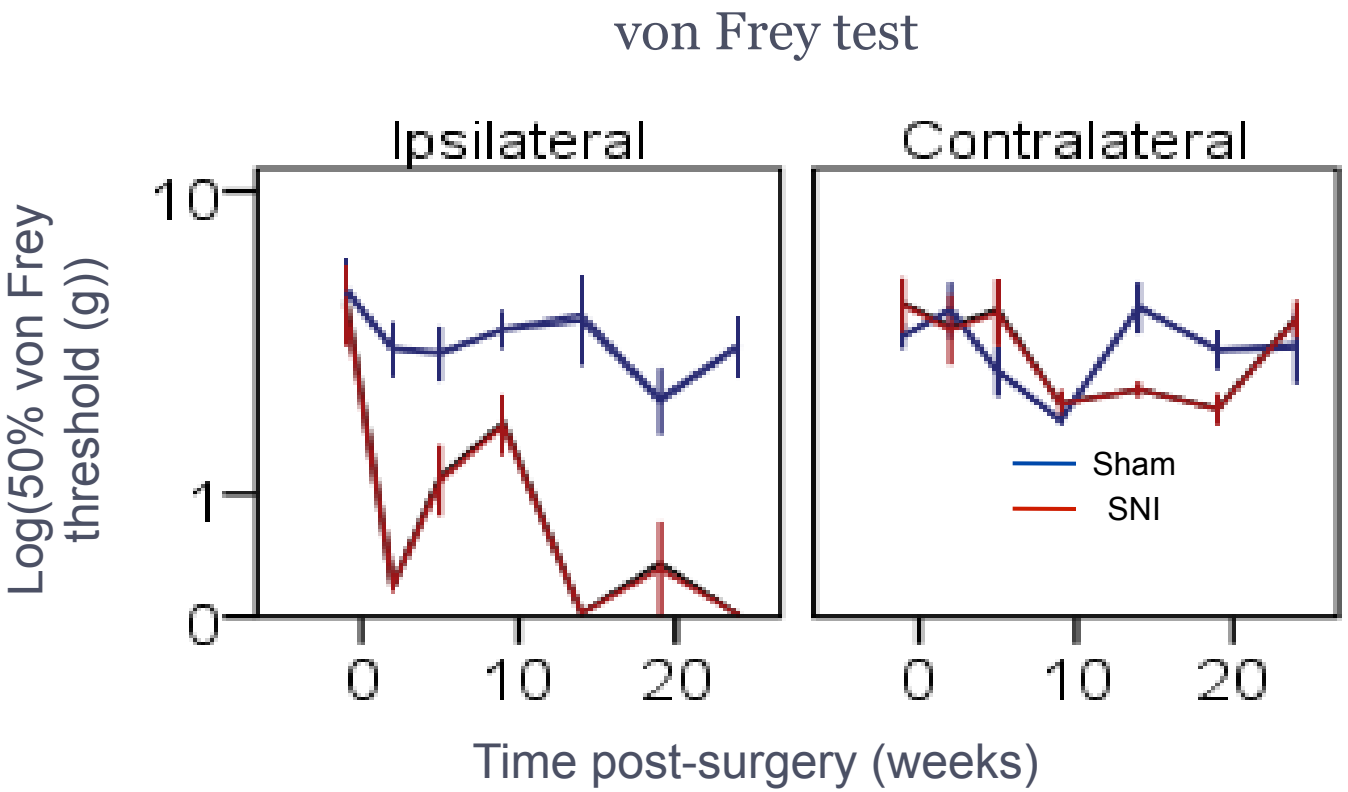




Seminowicz DA et al. Neuroimage, 2009.

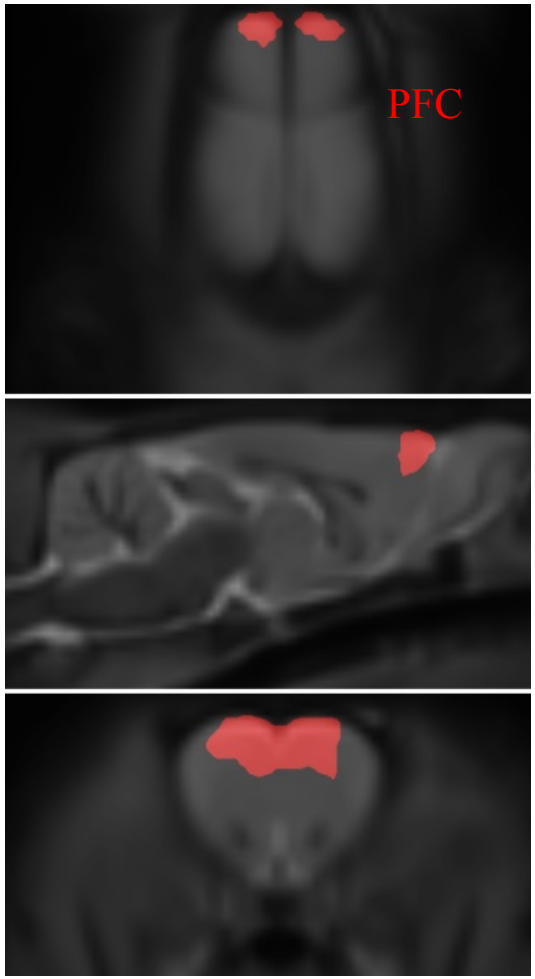
Mechanical hyperalgesia

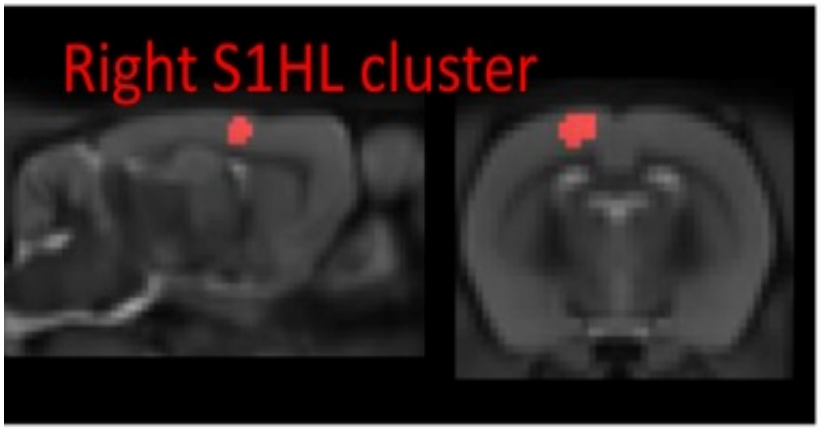


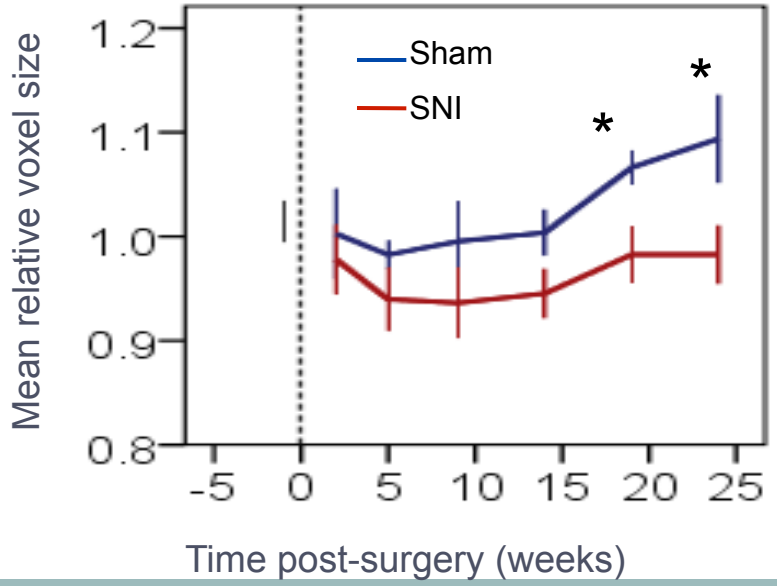


Seminowicz DA et al. Neuroimage, 2009.

Reduced cortical thickness in prefrontal cortex and S1

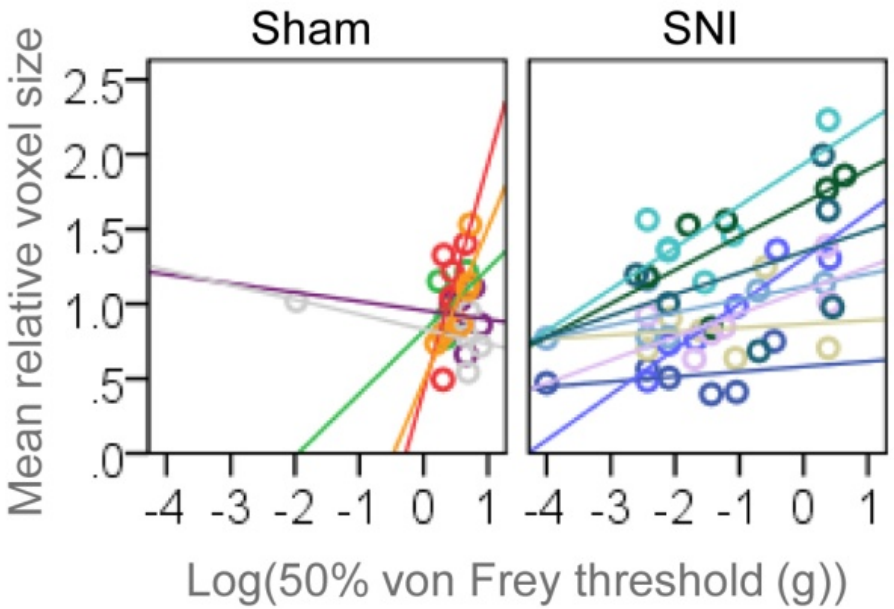






Seminowicz DA et al. Neuroimage, 2009.

Cortical thickness in S1 related to pain sensitivity



Seminowicz DA et al. Neuroimage, 2009.

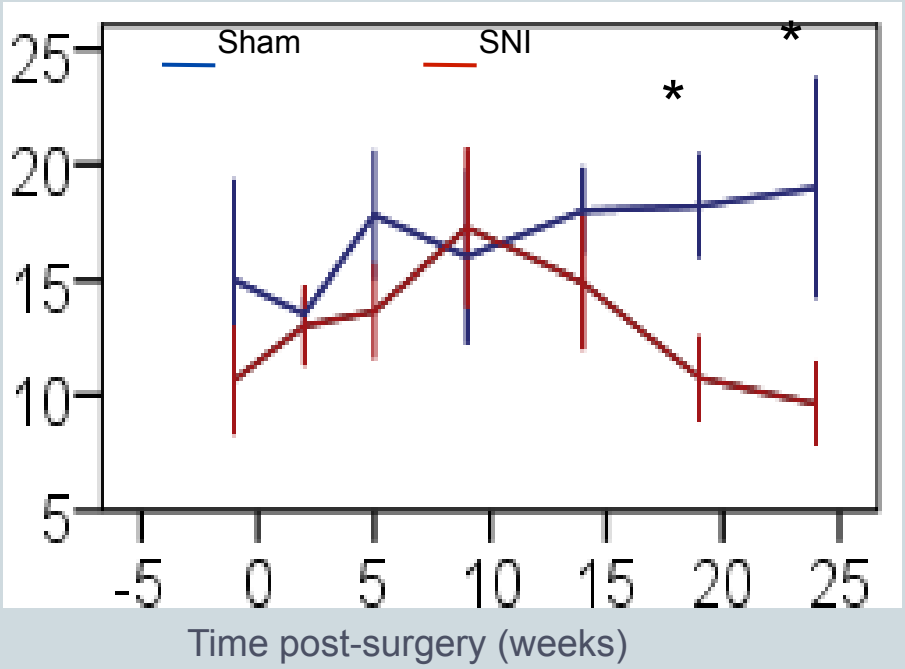
Pain patients have co-morbidities such as anxiety and depression

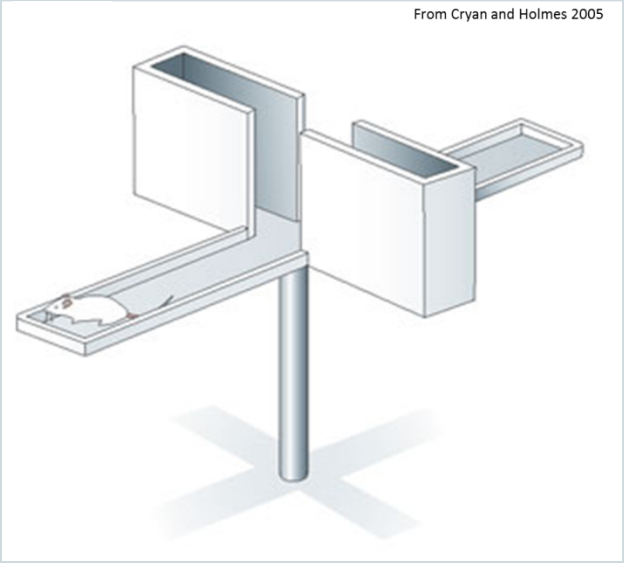
Rats show emotional behavior to pain

Sotocinal SG et al Mol. Pain 2011

After nerve injury, rats develop anxiety behavior

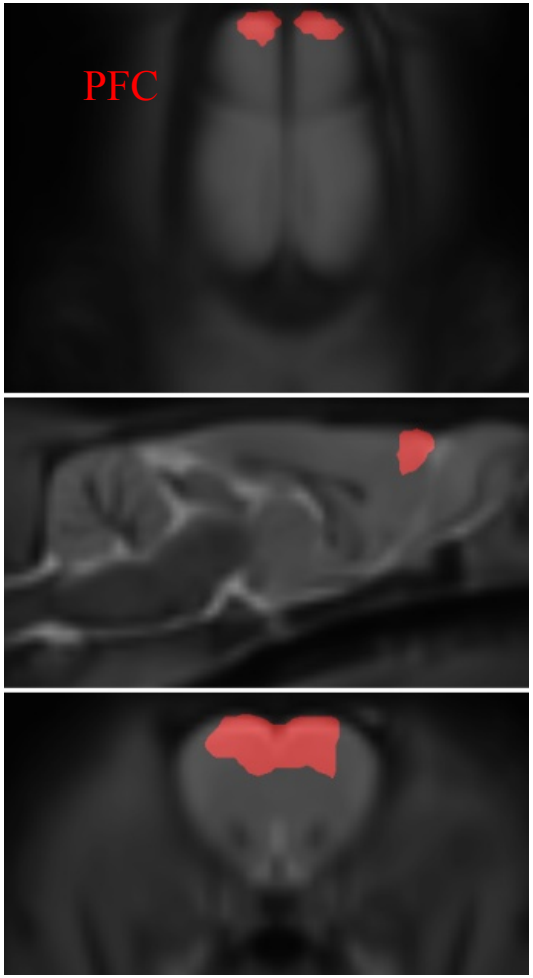
Elevated plus maze

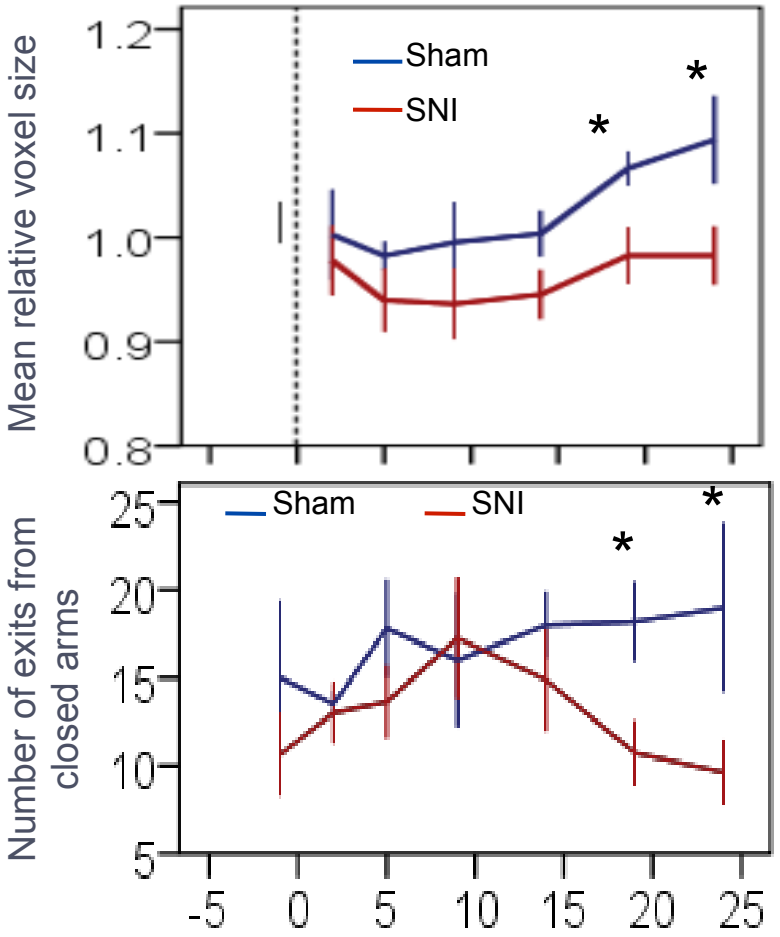




Seminowicz DA et al. Neuroimage, 2009.

Late prefrontal cortical changes coincident with increased anxiety





Seminowicz DA et al. Neuroimage, 2009.

Conclusions and directions

1. Animal MRI is evolving and may allow us to temporally examine functional and structural changes in the brain related to injury models.

2. PET methods can allow for functional imaging in awake unrestrained animals, as well as imaging of neurotransmitter systems and inflammatory processes.

3. Imaging procedures ultimately can be used to compare the effectiveness of therapeutic procedures when given at various time-points during development of chronic pain.