Central Sensitization in Chronic Pain

Pain itself can change how pain works, resulting in more pain with less provocation

updated Feb 19, 2017 (first published 2011)
by Paul Ingraham

Pain itself often modifies the way the central nervous system works, so that a patient actually becomes more sensitive and gets *more pain* with *less provocation*. It's called "**central sensitization**" because it involves changes in the *central* nervous system (CNS) in particular — the brain and the spinal cord. Sensitized patients are not only more sensitive to things that should hurt, but sometimes to ordinary touch and pressure as well. Their pain also "echoes," fading more slowly than in other people.

In more serious cases, the extreme over-sensitivity is obvious. But in mild cases — which are probably quite common — patients cannot really be sure that pain is actually worse than it "should" be, because there is nothing to compare it to except their own memories of pain.

This first section is a direct jargon-to-English translation of an important scientific paper by Clifford Woolf, a rock star of a pain researcher, published in *Pain* in Oct 2010. Everyone needs to know this: it's *owner's manual* stuff. After the translation, I offer some of my own ideas about what it all means for patients and professionals.

This rather awful thing is actually quite easy to create in the lab, like a mad scientist's monster. Any kind of noxious stimuli can trigger the change — anything that hurts skin, muscles or organs — and it can be reliably detected with special equipment. The role of sensitization in several common diseases [1] [2] has been well-documented, and could even be provoked by an irritant as unremarkable as muscle aches. [3] It can also persist and worsen in the absence without apparent provocation. And there's peripheral sensitization too. [4]

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Indeed, this neurological meltdown is such a consistent complication of other painful problems that some researchers now believe central sensitization is actually a major common denominator in most stubborn pain problems. It may be what puts the "chronic" in chronic pain, giving all such problems shared characteristics *regardless of how they got started* — not the *cause* of the pain, but the cause of its chronicity.

The existence of central sensitization is not in doubt. What is still unknown is why it happens to some people and not others. Both environment and genetics are probably factors — aren't they always? — but which genes, and what things in the environment? We just do not know yet, although we can certainly make an educated guess that it probably involves stress:

Another unfortunate gap in our scientific knowledge is that there are no clear criteria for diagnosing central sensitization. There is no easy lab test or checklist that can confirm it. [5] It could be present in nearly any difficult case of chronic pain, but it's not a sure thing — the pain could still be coming from a continuing problem in the tissue, with or without central

sensitization muddying the waters.

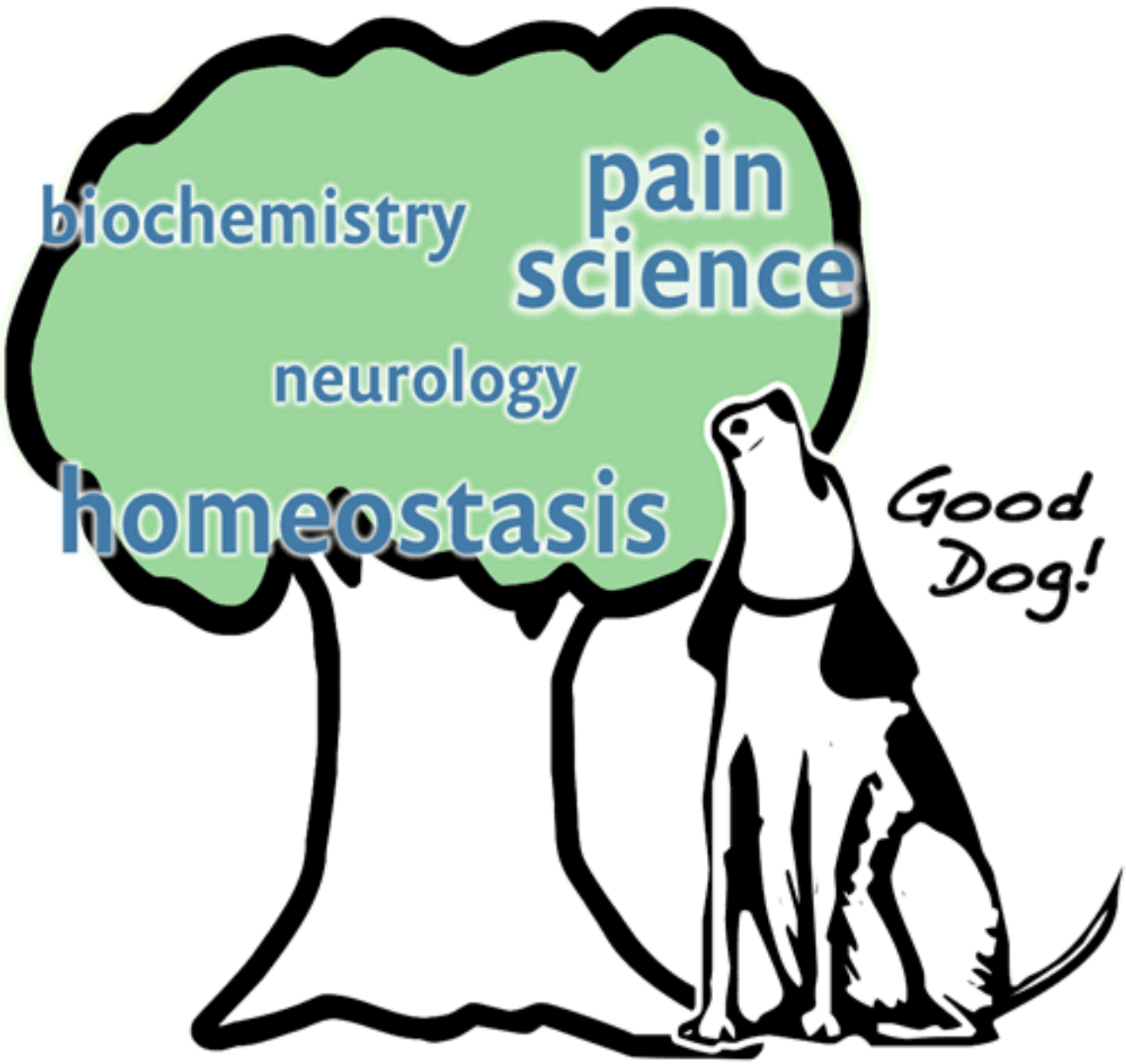
Hallucinating pain

One easy way to understand central sensitization is that it causes *pain hallucinations:* a bogus perception, but instead of seeing lizards on the walls, you feel pain that makes no sense.

There are some related conditions that are easier to understand. For instance, hyperacusis is an increased sensitivity to sounds, usually specific frequencies and volumes. Imagine a restaurant that sounds as loud as a rock concert. My father, a Vietnam veteran with PTSD, suffered from this condition for a couple years: he was *hallucinating loudness*. He spend a long time re-calibrating his sense of what "loud" is. A big part of that was asking my mother for an opinion on the loudness, and trusting her judgement: *yes, it really is loud in here* or *no, this really isn't very loud.* By frequently checking his perception against a healthy, objective assessment, he was able to slowly adjust his subjective volume scale.

But pain hallucination is a completely personal and internal experience, and there's no good way to check the validity of your pain. No one can tell you, *no, that really isn't very painful.* They cannot know. [6]

Pain hallucinations do not mean that pain isn't real. It usually means it's just a *too loud* interpretation of something that would hurt even if you weren't sensitized. It's also real in the same sense that hallucinations are caused by real neurological problems. When you feel pain you're not supposed to, it just means that the nervous system itself is damaged, rather than the tissues it's supposed to be reporting on. The pain system is borked. This may actually constitute an entire separate *type* of pain, distinct from neuropathic pain. [7]



Health care for pain problems remains overwhelmingly preoccupied with structural and biomechanical causes — they exist, but therapists hoping to diagnose pain that way are generally barking up the wrong tree. The last 20 years of pain science strongly suggest that neurology is by far the most important factor in most chronic pain.

Making a bad situation worse: the trouble with not knowing the neurology

> Even the clearest localization of pain in one area may, in fact, be originating from a distant area .... The reference of pain implies the existence of convergence of inputs within the spinal cord. This leads to the necessary involvement in central neural circuits in the simplest of peripheral disorders. It also leads to the possibility that the basic disorder is entirely central ...
>
> Professor Patrick D. Wall, FRS, DM, FRCP, in the Foreword to *Muscle Pain: Understanding its nature, diagnosis and treatment*

Pain is a warning system, and central sensitization is therefore a disease of *over-reaction to threats* to the organism — a hyperactive warning system. When physical therapists, massage therapists and chiropractors treat chronic pain patient too intensely, they may trigger that alarm system, potentially making the situation worse.

Central sensitization is bad news, but worse still is how few health care professionals are aware of the neurology and make things worse with careless or even *deliberately* rough, no-pain-no-gain treatment. It's bad enough that ignorance of central sensitization leads to wild goose chases and patients riding a merry-go-round of expensive and ineffective therapies, but

many kinds of therapy are also quite painful — and can make the problem worse. With tragic irony, the most likely victims are also the most vulnerable and desperate patients, patients going through the therapy grinder, their hopes leading them right into the hands of the most intense therapists.

The science of central sensitization is not all that new, but its surprising clinical implications are still emerging, and resisted by many health care professionals thinking well inside the box they were taught in. Their minds are firmly made up that pain is mainly "in" tissues, something wounded or irritated inside your meaty, gristly anatomy. Of course, trouble with tissues is important too — but the science has shown us that it is much less dominant a factor than anyone used to think. Countless studies now have shown a surprising, counter-intuitive disconnect between symptoms and problems plainly visible on scans. [8] Or, in rheumatoid arthritis, patients often suffer more pain than expected from just the inflammatory erosion of their joints [9] — and sensitization is probably the explanation for the "spread" of pain beyond their joints. [10] Factors like poor sleep quality may drive up sensitization, and thus are more of a cause of pain than anything going on in the tissues. [11]

Ignorance of central sensitization leads to wild goose chases and patients riding a merry-go-round of expensive and ineffective therapies.

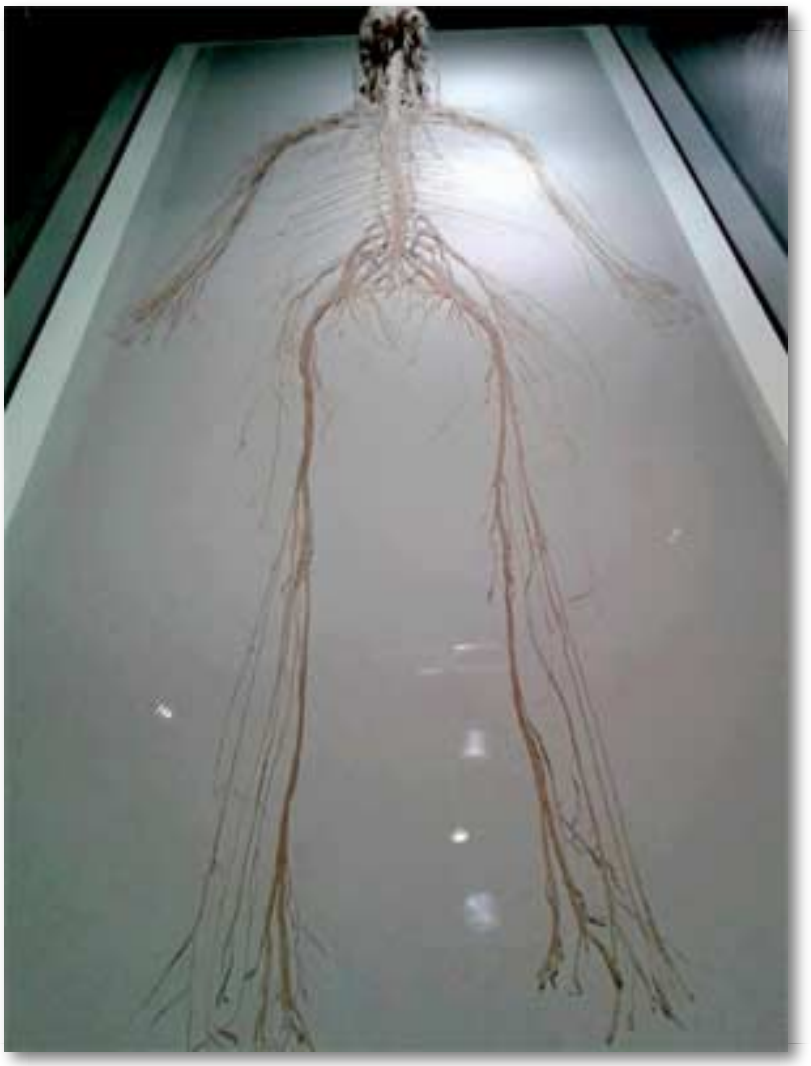
It's actually quite astonishing how *little* pain is caused by some seemingly dramatic issues in your tissues! "The evidence that tissue pathology does not explain chronic pain is overwhelming (e.g., in back pain, neck pain, and knee osteoarthritis)." (Moseley)

It all starts to make a lot more sense when you understand how the your pain system works — that pain is strongly regulated by the brain.

Professionals may pay some lip service to the importance of integrating neurological considerations into treatment, but their respect is often more poetic and politically correct than practical. [12] Care for chronic pain of all kinds needs to *soothe and normalize* the nervous system — not challenge it with vigorous manipulations.

What should patients do? (Professionals should read this too!)

Patients with stubborn pain problems should start trying to decide if they are experiencing "too much" pain — more than seems to "make sense." It's not an easy question to answer. When we hurt, it always seems like a big deal! Again, it's just like a patient with hyperacusis trying to figure out if sounds are actually too loud, or just *seem* that way. Unfortunately, a pain patient cannot ask anyone: "Does that seem really painful to you? Or is that just my central sensitization?"



You've got some nerve

Pay attention to this. Not much else matters if this part of you isn't happy.

If you suspect that your nervous system is no longer giving you useful, sensible pain signals, then be extra cautious about painfully intense therapies and skeptical of biomechanical explanations for your pain (i.e. "you hurt because you have a short leg") — such factors are only part of the picture, and probably the least important part. Make sure any professional you see is aware of the phenomenon of central sensitization, and start using that as a criteria for judging the quality of their services — if your doctor or therapist doesn't act like they know what central sensitization is, take your business elsewhere.

You might go through quite a few professionals before finding one who shows some "sensitivity to sensitivity."

Medications that work on the central nervous system **13** are probably the most promising treatment for serious pain system dysfunction. Only a physician trained in the care of chronic pain can prescribe those medications. The best place to look for such a doctor is in a pain clinic — if you have serious chronic pain, you should start looking for one today.

Finally, regardless of whether or not central sensitization is actually happening in your body now, it always makes sense to *be kind to your central nervous system.* Make your life "safer" and less stressful. Gentler. Easier. Centralization of pain is the process of the central nervous system's "opinion" of the situation becoming more important than the actual state of the tissues. This is not an "all in the head" problem, but a "strongly affected by the head" problem, like an ulcer that is caused by a very real bug but is severely aggravated by stress.

When your CNS is "freaked out" and over-interpreting every signal from the tissues as more painful than it should, therapy becomes more about soothing yourself and feeling safe than about fixing tissues. Pain is, at a very fundamental level, all about your brain's assessment of safety: unsafe things hurt. If your brain thinks you're safe, pain goes down.

So, for the chronic pain sufferer, cultivating "life balance" and peacefulness is a logical foundation for recovery, more important than just a pleasing philosophy — and it's a worthwhile challenge even if it fails as therapy, of course. This is what I always meant by the idea of "healing by growing up," long before I had even heard of central sensitization.

What should professionals do? (Patients should read this too!)

At the end of this section, I provide some practical sensitization-friendly treatment principles in point form — but they follow almost automatically from education, which is the main thing. Professionals need to get their bums into gear and simply *learn more about central sensitization* and pain neurology generally. Once you've learned more about sensitization, it's hard *not* to do start doing things differently.

Start deconstructing your assumptions about pain with my article on the follies and inconsistencies of structural models of pain, and also read Eyal Lederman's more academic treatments of the same topic (on low back pain, and core strengthening). Then read Clifford Woolf's excellent 2010 tutorial, "Central sensitization: Implications for the diagnosis and treatment of pain" — it's heavy reading, but worth the mental exertion.

There are two websites that consistently produce good, readable, science-based information and resources about central sensitization and related topics: Body In Mind and the NOI Group. Also, physical therapist Diane Jacobs is extremely active on Facebook, constantly sharing valuable information on this theme on her page, Neuroscience and Pain Science for Manual Physical Therapists.

A massage therapist once inflicted extreme discomfort on my armpit because she believed that there were evil "restrictions" in there.

Finally: please start treating pain patients like they might have a janky nervous system that is over-reacting to every possible perceived threat — and *stop* chasing the red herrings of subtle biomechanical problem of dubious clinical relevance, that are mostly nearly impossible to prove or treat anyway, and which often lead you to try to apply to much pressure to tissues. For example, a massage therapist once inflicted extreme discomfort on my armpit because she believed that there were evil "restrictions" in there and that she could rip her way to a cure of a shoulder problem I didn't even really have. All she accomplished was to swamp my nervous system with nociception, and it could have been disastrous if I'd been a chronic pain patient.

Instead of trying to "fix" anything, seek to create (or at least contribute to) a *felt experience of wellness.* Make therapy pleasant, easy, and reassuring. Help the patient remember what it's like to feel safe and good.

This transition can be immensely liberating: it can put an end to the wild goose chases for sources of pain in the tissues in many of your toughest cases.

Fundamentals of Treatment (aka Axioms of Function, by Greg Lehman)

These principles are described in detail in Don't Freak Out by Greg Lehman, BKin, MSc, DC, MScPT. All great points, but the most neglected, important, and relevant to sensitization is obviously #4.

1. Rule out red flags
2. Rule out serious tissue pathology
3. The body is strong and adaptable
4. Pain is more about sensitivity than about injury
5. Treatment is about finding the appropriate stressor
6. The patient is an active participant in their own care
7. Decorations ("Useful Though Not Fundamental Axioms")
    - Gauge your treatments by assessing sensitivity
    - Manual therapy is an adjunct to fundamentals
    - Your assessment reinforces their belief in strength

- Comprehensive capacity trumps assessment-driven correctives
- Postural and movement assessments reveal habits but not flaws

About Paul Ingraham

I am a science writer, former massage therapist, and I was the assistant editor at ScienceBasedMedicine.org for several years. I have had my share of injuries and pain challenges as a runner and ultimate player. My wife and I live in downtown Vancouver, Canada. See my full bio and qualifications, or my blog, Writerly. You might run into me on Facebook or Twitter.

Appendix: The actual Woolf abstract

You can see why I thought it needed translation. 😜

> “Central sensitization: Implications for the diagnosis and treatment of pain”
> Woolf. *Pain.* Volume 152, Number 2 Suppl, S2–15. Oct 2010.
>
> Nociceptor inputs can trigger a prolonged but reversible increase in the excitability and synaptic efficacy of neurons in central nociceptive pathways, the phenomenon of central sensitization. Central sensitization manifests as pain hypersensitivity, particularly dynamic tactile allodynia, secondary punctate or pressure hyperalgesia, aftersensations, and enhanced temporal summation. It can be readily and rapidly elicited in human volunteers by diverse experimental noxious conditioning stimuli to skin, muscles or viscera, and in addition to producing pain hypersensitivity, results in secondary changes in brain activity that can be detected by electrophysiological or imaging techniques. Studies in clinical cohorts reveal changes in pain sensitivity that have been interpreted as revealing an important contribution of central sensitization to the pain phenotype in patients with fibromyalgia, osteoarthritis, musculoskeletal disorders with generalized pain hypersensitivity, headache, temporomandibular joint disorders, dental pain, neuropathic pain, visceral pain hypersensitivity disorders and post-surgical pain. The comorbidity of those pain hypersensitivity syndromes that present in the absence of inflammation or a neural lesion, their similar pattern of clinical presentation and response to centrally acting analgesics, may reflect a commonality of central sensitization to their pathophysiology. An important question that still needs to be determined is whether there are individuals with a higher inherited propensity for developing central sensitization than others, and if so, whether this conveys an increased risk in both developing conditions with pain hypersensitivity, and their chronification. Diagnostic criteria to establish the presence of central sensitization in patients will greatly assist the phenotyping of patients for choosing treatments that produce analgesia by normalizing hyperexcitable central neural activity. We have certainly come a long way since the first discovery of activity-

dependent synaptic plasticity in the spinal cord and the revelation that it occurs and produces pain hypersensitivity in patients. Nevertheless, discovering the genetic and environmental contributors to and objective biomarkers of central sensitization will be highly beneficial, as will additional treatment options to prevent or reduce this prevalent and promiscuous form of pain plasticity.

Related Reading

This article is tightly focussed on the topic of central sensitization. For a much more general article about how pain works, see:

Pain is Weird Pain science reveals a volatile, misleading sensation that is often more than just a symptom, and sometimes worse than whatever started it ~ 10,000 words

Some other relevant articles:

- The Basic Types of Pain — Nociceptive, neuropathic, and "other"
- 12 Surprising Causes of Pain — Trying to understand pain when there is no obvious explanation
- Why Does Pain Hurt? — How an evolutionary wrong turn led to a biological glitch that condemned the animal kingdom — you included — to much louder, longer pain
- Pain & Injury Survival Tips — Dozens of ideas (and links) for evidence-based rehabilitation and self-treatment for common pain problems and injuries
- When to Worry About Neck Pain...and when not to! — Tips, checklists, and non-scary possible explanations for neck pain

What's new in this article?

February — Several minor clarifications and a new footnote about peripheral sensitization.

2016 — Added a special sidebar, "Fundamentals of Treatment" — some practical, sensitization-friendly treatment principles for pros.

2016 — Added citation about the effect on sleep problems on sensitization.

2011 — Publication.

Notes

1. These include fibromyalgia, osteoarthritis, irritable bowel syndrome, musculoskeletal disorders with generalized pain hypersensitivity (often called myofascial pain syndrome or "trigger points"), tension headaches, temporomandibular joint disorders, dental pain, neuropathic (nerve injury) pain, visceral pain hypersensitivity disorders and post-surgical pain.

2. Havelin J, Imbert I, Cormier J, *et al*. Central sensitization and neuropathic features of ongoing pain in a rat model of advanced osteoarthritis. *J Pain*. 2015 Dec. PubMed #26694132.

   In rats, long term osteoarthritis pain eventually turns into more of a neurological problem than a joint problem. That is, the pain gets disconnected from the conditions of their little joints. It's likely this occurs in humans too, and it could lead to "treatment of advanced OA pain without the need for joint replacement."

3. Mense S. Muscle pain: mechanisms and clinical significance. *Deutsches Ärzteblatt international*. 2008 Mar;105(12):214–9. PubMed #19629211. PainSci #54165. "Low frequency activity in muscle nociceptors is sufficient to induce central sensitization." This is speculation, but reasonable. *Any* pain may be "sufficient to induce central sensitization," but muscle pain just happens to be a particularly common source of pain, usually occuring without any obvious cause: like pimples, sore spots in muscle "just happen." See The Trigger Point Identity Crisis.

4. Pain may be amplified as a result of more and stronger nerve signals coming from tissues instead of (or in addition to) a CNS over-reaction to fewer and weaker ones. More exactly, peripheral sensitization is caused by nerve endings firing much more easily than normal (lower transduction threshold, higher membrane excitability). This phenomenon may be temporarily dialed up around injury sites to keep you respectful of fragile tissue. It may occur in the aftermath of injury to nerves themselves, a mechanism for chronic neuropathic pain (Costigan 2009), which some people may be more prone to, thanks to their genes (Costigan 2010). Or it may be one aspect of a bigger problem with central sensitization picture: sensitization everywhere, central and peripheral.

5. The key word there is "easy" — as explained above, it's definitely *possible*, but the advanced research techniques used to prove the existence of the problem simply aren't available to health care consumers, and may not be for a long time.

6. Actually, they sort of can, at least when there's an external noxious stimuli. Although pain is very personal, painful things — a hard poke, say, or an electric shock — do produce fairly predictable pain ratings. That is, most people will respond to a 10 lb poke in the chest with approximately the same pain rating. If most people call it a 2-3 on a pain-scale from 1-10, then you know you're probably sensitized if you think it's a 5 or 6. It's not a precise diagnostic method, but there is actually such a thing as an roughly objective measurement of how painful something is. Unfortunately, it's rarely applicable to chronic pain cases, where the noxious stimuli is often completely unknown or can't be reproduced outside the body.

   For instance, when I suffered for a year from a strange tonsil pain, I had no way of knowing if the pain was "correct" — because I didn't know what the noxious stimuli was. It turned out to be a tonsil stone, unusually hard and sharp. But even after it came out, solving the problem… how do you judge how painful a tonsil stone *should* be? You can't exactly stick a rock in the tonsils of fifty test subjects for months to see how *they* rate it — that would be unethical! But that was basically the problem. Not once in that whole miserable year did I have any way of knowing if my pain was a correct, proportionate response to a stimulus. And — true story — I was actually diagnosed with "central sensitization" two months before the stone was discovered and came out.

7. Neuropathic pain is the pain caused by "insulted" nervous system tissues. Actual trauma to nerves is required by the definition of neuropathy (a relatively recent development), so central sensitization cannot be "neuropathic" See The Basic Types of Pain.

8. Many examples of that science are described in the article Your Back Is Not Out of Alignment. It's a major theme in modern pain and orthopedic science, which can only be missed by pretty much ignoring the literature since 1990.

9. Younes M, Belghali S, Kriaa S, *et al*. Compared imaging of the rheumatoid cervical spine: Prevalence study and associated factors. *Joint Bone Spine*. 2009 Jul;76(4):361–368. PubMed #19303343.

   Surprisingly, disease-driven erosion of cervical joints can be painless. Rheumatoid arthritis — a nasty disease, quite different from garden variety "wear and tear" osteoarthritis — commonly attacks the joints of the neck, causing significant deformity of the joints. Although this does often cause severe pain, it doesn't always: this study reports that 17% of 29 patients were asymptomatic, even with substantial joint degradation revealed by MRI, CT, or X-ray.

   Another important finding of this study: whether it hurts or not, the cervical spine was damaged in 75% of patients: "Cervical spine involvement is common and may be asymptomatic, indicating that routine cervical spine imaging is indicated in patients with RA."

10. Meeus M, Vervisch S, De Clerck LS, *et al*. Central sensitization in patients with rheumatoid arthritis: a systematic literature review. *Seminars in Arthritis and Rheumatism*. 2012 Feb;41(4):556–67. PubMed #22035625. Rheumatoid arthritis is a nasty source of chronic pain, but could some of the pain be caused by central sensitization instead of the disease itself? Meeus *et al.* concluded that there are signs of this, from analyzing 24 scientific papers (although "more research is needed," of course). RA mainly attacks joints, but patients often experience pain elsewhere, and in response to a variety of stimuli, and symmetrically — all of which are a good fit for central sensitization. Also, as with many other chronic pain conditions, in RA there's often more (or less) pain than detectable tissue trouble (see previous note), indicating that the progress of the disease is probably not the only driver of pain. Sensitization may be the best way to explain this.

11. Burton E, Campbell C, Robinson M, *et al*. Sleep mediates the relationship between central sensitization and clinical pain. *The Journal of Pain*. 2016 2016/05/03;17(4):S56. PainSci #53398. This experiment looked carefully 133 patients with knee arthritis, comparing those who slept well versus those who did not. They found, with a high degree of certainty, that "sleep fragmentation may strongly affect the pain and CS relationship; consequently, these results underscore the importance of considering and treating sleep in patients with chronic pain."

12. For example, many massage therapists regard the "magic" of touch as a sort of nice bonus or sensory gravy in massage therapy. But *it's the main thing* — in fact, pretty much the *only* thing that massage therapists can do that may prevent or reduce the phenomenon of central sensitization, which we now know to be a major factor in many or perhaps most of the toughest cases.

13. The potent and generally dangerous and addictive ones, that is — not over-the-counter pain drugs like ibuprofen and acetaminophen.