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## Chiropractic Science: A Contemporary Neurophysiologic Paradigm

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In order for chiropractic to reach its full potential as a healthcare profession, it must be universally integrated into the mainstream healthcare model. For this to be realized, chiropractic must first be unconditionally embraced

by mainstream science. With growing competition for today's healthcare dollar, health policy makers are increasingly relying on an evidence basis to guide decision making. The value that government and other stakeholders assign to chiropractic services will rely on the ability for chiropractic to validate the basic physiologic mechanisms of spinal manipulative therapy through high quality controlled studies.

### Central Sensitization and Neurogenic Inflammation: The Neurophysiologic Pillars of the Contemporary Chiropractic Paradigm

The evidence suggests that effects of spinal manipulative therapy is primarily neurophysiologic, most likely mediated by intense stimulation of large myelinated fibers in the capsular and/or periarticular tissues.<sup>1</sup> Basic science also demonstrates that large fiber stimulation can modulate dorsal horn excitability by inducing segmental inhibitory mechanisms.<sup>2</sup> The phenomenon of dorsal horn excitability, also referred to as central facilitation or sensitization, is pivotal to the contemporary chiropractic paradigm. Sensitization is defined as a heightened responsiveness of a neuron to an input stimulus.<sup>3</sup> Central sensitization is defined as heightened responsiveness of a second (or higher) order neuron in the nervous system.<sup>4</sup>

Central sensitization has been clinically observed with a broad spectrum of pathologies but its cause-effect relationship is still unclear. It is the result of sustained peripheral nociceptive inputs into the dorsal horn<sup>5</sup> and these nociceptive inputs may originate from a broad spectrum of etiologies.<sup>6</sup> Nociception arising from axial tissues is more likely to initiate central sensitization than peripheral tissues and it has been suggested that spinal pathomechanics produces changes in dorsal horn excitability.<sup>7</sup> These collective observations imply that the spine and its asso-

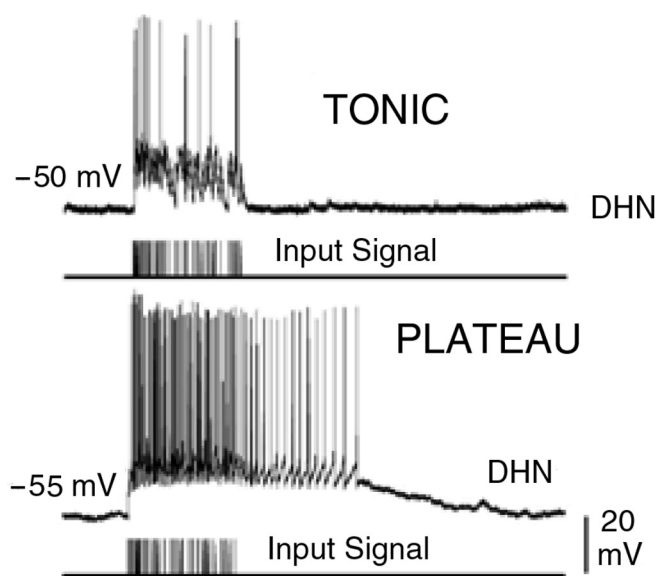


Figure 1 *Input – Response Profile of Tonic (normal) vs Plateau (sensitized) states of the Dorsal Horn Neuron (DHN) in rats (Derjean, 2003). The DHN’s response signal (top tracing in each example) in the plateau state demonstrates a higher frequency and longer duration as compared with tonic DHNs. Input signal (bottom tracing in each example) is identical in both examples. (Adapted with permission from Derjean, 2003)*

ciated structures may be important considerations in the pathophysiology of central sensitization.

Central sensitization is a neuroadaptive mechanism with significant implications in the study of pain, joint mechanics, disease and optimal health. One of the most important reasons for this is that central sensitization has significant impact on signal transmission in the dorsal horn. Electrophysiologic data from animal models demonstrate that dorsal horn sensitization can lead to considerable signal amplification and persistent firing.<sup>8</sup> A comparison of response profiles from sensitized (plateau) versus normal (tonic) dorsal horn neurons in rats (Figure 1) reveals that sensitized dorsal horn neurons not only exhibit higher response frequencies but also show persistent activity after removal of the input signal.<sup>8</sup> The physiologic importance of this is that the information encoded in the input signal (peripheral afferent) is clearly modulated in the sensitized state, as compared to the tonic state. These altered signals

are then either transmitted to higher levels of the nervous system or directly to effector organs where they may initiate abnormal physiologic responses and, potentially, pathogenic processes if allowed to persist. These mechanisms may therefore be the neurophysiologic basis for how disease and dysfunction of the spine impacts health and disease. How these aberrant signals are processed, and what role spinal manipulative therapy plays in modulating these signals, is an important area for chiropractic research because these concepts form the foundation for the neurophysiologic paradigm of chiropractic.

Another mechanism by which central sensitization may impact health is through the initiation of a process known as neurogenic inflammation. Neurogenic inflammation is defined as a peripheral inflammatory response that is mediated antidromically through nociceptors.<sup>9</sup> This phenomenon is caused by the release of proinflammatory mediators peripherally via antidromic mechanisms to create a localized inflammatory response in the receptive field of the affected nociceptor. Central sensitization has been recognized as a primary cause of neurogenic inflammation.

The importance of neurogenic inflammation is its potential role in the clinical expression of somato-visceral and viscerosomatic responses. Convergence of neural tracts is a basic architectural construct of the nervous system and the dorsal horn is where nociceptors of somatic and visceral origin are known to converge. Consequently, somatic pain, especially pain of axial (spinal) origin, can sensitize the dorsal horn to evoke neurogenic inflammatory responses in visceral pathways, and vice-versa. This phenomenon has been confirmed experimentally in animal models<sup>10–13</sup> and has also been hypothesized as a primary mechanism in the pathophysiology of myofascial pain syndrome.<sup>14</sup>

#### Modulation of Central Sensitization: The Neurophysiologic Basis for Spinal Manipulation in Health and Wellness Management

Spinal manipulation-evoked modulation of central sensitization is an important, and perhaps foundational, scientific tenet which has the potential to establish chiropractic as an essential player in the future of mainstream healthcare. Furthermore, based on this rationale, chiropractic is well-positioned to play a leading role the conservative management of somatic pain such as myofascial pain

syndrome, an increasingly prevalent condition of generalized muscle pain resulting from central sensitization.<sup>15</sup> The incidence of myofascial pain in the elderly is reported as high as 85% and it is estimated that by the year 2050 the ratio of the elderly population to general population in Canada will double,<sup>16</sup> making myofascial pain syndrome one of healthcare's foremost challenges. Ensuring its role in the future of mainstream health and wellness care will rely on the ability for chiropractic research to validate these physiologic mechanisms using the language of basic science.

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