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The Vertebral Subluxation premise:
Principle 2, the somatic vertebrogenic element

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Narrative: This is the third of a 6-paper series which presents a descriptive narrative of the Western medical literature to identify and report evidence for each of the five principles of the Vertebral Subluxation Complex (VSC) premise as established in 1947 by Janse, Houser, and Wells (National College of Chiropractic). This literature is additional to that from the chiropractic perspective which is available in the electronic *Index to Chiropractic Literature*.

The first paper, in two parts, introduced the series and gave evidence for Principle One that '*a vertebrae may subluxate*'. This third paper presents the evidence for Principle Two by documenting the evidence for the factors associated with the somatic vertebrogenic element.

This 6-part series describes the incontrovertible acknowledgement and weight of recognition of the effect of physical, biomechanical, and physiological vertebral disturbances collectively contributing to the VSC and demonstrates strong support of the chiropractic nomenclature, neurophysiological and clinical implications of the Vertebral Subluxation Complex as recorded in the medical literature.

Indexing terms: Subluxation; Vertebral Subluxation Complex (VSC); biomechanics; neurophysiology, connective tissue.

Editor's note:

Rome and Waterhouse have together perhaps the most thorough understanding of the medical literature from the mid 20th Century to this moment in respect to its voluminous descriptions of spinal lesions known to chiropractors as indicative of the Vertebral Subluxation Complex (VSC).

> *... Principle 2 of the VSC is that there is a vertebrogenic element and this may be associated with disturbances of biomechanical, neurophysiological, and other connective tissue structures ...'*

This third paper in our new series of 6 papers explores Principle 2, that there are vertebrogenic elements of the VSC which may be associated with identifiable clinical phenomena.

The reporting of Rome and Waterhouse is so extensive that the *Journal* is publishing these 6 papers as Principle 1 Part 1 here with Part 2 here, Principle 3 here, Principle 4 here and Principle 5 here. This paper addresses Principle 2. These papers are also collected on the *Journal* website as 'MasterClasses' as an invaluable reference base.

To maximise the usefulness of these papers, each key narrative element is immediately supported by a compendium of source references, a departure from the usual practice of collecting cited references at the end of the work.

Phillip Ebrall
Editor

This series to date ...

The first paper, Part Part 1 of Principle One, established that the clinical practices of Chiropractic, manipulative medicine and Osteopathy collectively recognise the biomechanical and physiological phenomena and associated neural ramifications of spinal lesions.

We presented the preponderance of papers from the field of manipulative medicine which support the chiropractic nomenclature of of the Vertebral Subluxation Complex. We continue by reporting the literature relating to the onset of spinal dysfunctions known by Chiropractors as the VSC.

Introduction to Paper 3, Principle 2

'that there is a vertebrogenic element which may be associated with disturbances of biomechanical, neurophysiological, and other connective tissue structures'

Component models of the subluxation

In a comprehensive review, Kent (1996) identified four primary models of subluxations. He noted that these may impart their influence independently or in any combination.

Possible neurobiological mechanisms associated with vertebral subluxations include compression, stretch, dysafferentation, dyskinesia, dysponesis, dysautonomia, neuroplasticity and ephaptic transmission. (Kent, 1996; 2019)

Within these models are further elements which may be included:

- Neuropathophysiology – noxious somatosensory input, somato-autopnomic reflexes.
- Kinesiopathology – dysfunction,
- Myopathology – applied kinesiology, muscle strength/weakness, muscle tone.
- Histopathology - somatovisceral reflexes.
- Biochemical changes – somatovascular reflexes.
- CSF flow (After Faye,1986; Seaman & Faye, 2005; Rosa & Baird, 2015)

In 2021, a comprehensive paper by Haavik et al detailed in neurophysiological terms the complex nature of both subluxation and the adjustment. They highlighted the role that the vertebral adjustment and spinal manipulation may have to influence central segmental motor control and neuromuscular function. They noted that cervical spine injury may contribute to visual, vestibular and coordination disturbances, which may influence the CNS and the potential for manual intervention to influence these. (Haavik et al 2021a; Haavik et al, 2021b)

Degeneration model (Kent 1996)

Degenerative facet and disc changes bring the osseous structures closer together. Initially however an inflammatory reaction may increase the interarticular space. Both situations are likely to activate the articular sensory receptors and alter the physiological mechanical functions, but nerve root compromise is also possible. Consequential reduction of the intervertebral foramen (IVF) would have the potential to influence the integrity of the nerve roots. (Schwarzer et al, 1994)

Hadley (1976, p. 174) also suggested that degenerative changes in intervertebral discs and articular facets may also be factors responsible for subluxation elements.

Nerve root compression model

(Kent 1996)

Nerve roots may also be influenced by compression of the constituents of the intervertebral foramen. Kent notes the possibility of venous congestion.

We would add potential changes in extracellular and intracellular as well as colloid osmotic fluid pressures and electrolyte exchanges along the nerve root at a cell membrane level. It is further hypothesised that these may result in alterations in ion exchange and altered *Donnan's equilibrium*. Stasis of the IVF may also influence O_2 and particularly the pH levels in the cerebrospinal fluid pressures on the neural sleeve at that level. The possibility of such radicular changes affecting neural transmission has not been explored to our knowledge. (Giles, 1992; Song et al, 2003; Whedon 2009)

Dysafferentation model

(Kent 1996)

This relates to the increased neuropathological nociceptive input together with reduced input from mechanoreceptor sensory influence. In particular in segments with hypomobility, there is a diminution of mechanoreceptive input and increased nociceptive afference. (Seaman & Winterstein, 1998; NZCA ,undated)

Neurodystrophic model

(Kent 1996)

This model essentially encompasses the effect neural disturbances may have on innervated structures. Henderson identifies these as intervertebral encroachment, altered somatic afferent input and dentate ligament, cord distortion. (Henderson 2005; Vernon 1995)

Neuroplasticity element

(Kent 2019)

This element notes how brain neurons respond to neural input from internal and external environment by plastic changes.

While these are generally favourable, Kent notes that maladaptive neuroplastic changes may develop as a response to noxious subluxation sensory input as noted by Holt et al. (2019)

Much research on this aspect has been summarised and published online by the *Australian Spinal Research Foundatio*n (Circa 2019) and others. (Bakkum et al, 2007; Jänig, 2013; Murphy & Haavik, 2014; Holt et al, 2019; Navid et al, 2021; Hiraga et al. 2022)

Dyskinesia

(Kent 2019)

Dyskinesia is related to the postural or global dysfunction in the form of a restriction in a patient's voluntary range of motions. Historically, Goldthwait et al (1952, p. 181) stated '*Good body mechanics is essential for the proper functioning of the nervous system. The effects of bad body mechanics upon this system are expressed indirectly, chiefly through the locomotor and the circulatory systems*,' with autonomic implications. (p. 192) They noted that Pottenger (1930) also suggested that disturbances of the sympathetic nervous system can be explained on a mechanical basis.

Dysponesis

(Kent 2019)

Dysponesis is another neural aberration or tonal changes as reflected in muscle tonal alterations. (McDowall, 2017; 2021) These may be apparent with muscle testing, co-ordination of head positioning (proprioceptive) and demonstrable by surface electromyography.

Whatmore et al (1968) describe dysponesis '*as a physiopathologic state that is a hidden etiologic factor in a number of common clinical syndromes, and can give rise to a variety of*

functional disturbances within the organism. It is basically a reversible physiopathologic state composed of errors in energy expenditure that interfere with nervous system function and thus with control of organ function. Its detrimental influence is exerted by means of excitatory and inhibitory patterns of signal input at widespread points within the complex networks of the nervous system, resulting in reduction in the organism's productivity and disturbance of its emotional reactivity, ideation, and central regulation of various organs of the body.'

Dysponesis is defined as a reversible physiopathologic state consisting of unnoticed, misdirected neurophysiologic reactions to various agents (environmental events, bodily sensations, emotions, and thoughts) and the repercussions of these reactions throughout the organism. (Encyclo Co UK, Undated; Fletcher undated; Kent 2011)

Dysautonomia (Kent 2019)

The autonomic nervous system regulates and coordinates smooth muscle. The influence of activated somato-autonomic reflexes by noxious sensory input is thought to be one of the primary adverse influences of subluxations. Cervicogenic headaches may be an example. (Budgell & Sato, 1996; Bussone & Usai, 2004; Cramer et al, 2006; Jänig. 2003, May 2003; Rome & Waterhouse, 2020; Sato & Schmidt, 1987; Sato 1997; Seaman & Winterstein, 1998)

Ephaptic transmission (Kent 2019)

This hypothetical concept relates to the neural electrical field effect on adjacent neurons without passing through a synapse. We surmise that this may happen with hyperactivated noxious input as a type of spillover. (Nishiyama, 2007)

Cerebrospinal fluid flow

Apart from evidence of neural and vascular effects form vertebral subluxations, evidence is emerging of an effect on the flow of cerebrospinal fluid (CSF) at the suboccipital level.

Based on current research there are other elements of the subluxation apart from the noxious somatosensory-autonomic model, this includes disruption of CSF flow. However, these findings relate primarily to the sensory irritation from past trauma although these may well be present with recent trauma together with a red flag of recent fracture and considering the more subtle minor degrees of fracture, including occult fractures. (Rosa & Baird, 2015)

Three neurophysiologic models (Henderson, 2005)

Henderson proposed three well-supported neurological theories on the subluxation.

We tend to agree with him that there are likely to be elements of these and possibly other hypotheses over the lifetime of a subluxation:

- Intervertebral Encroachment Theory
- Altered Somatic Afferent Input Theory. [It is this element that is primarily addressed in this paper]
- Dentate Ligament, Cord Distortion Theory

Four subluxation models (Mootz, 2005)

Mootz offered four hypotheses of the vertebral subluxation complex from a somewhat different perspective and breaks them down further. Again, it is possible that all elements may exist or become a part of this clinical finding.

- Biomechanical model
- Neurologic model

- Trophic model
- Psychosocial model

While a definitive understanding of VSC is still emerging like many developments on the health sciences, ongoing research continues to expand and explain the neurophysiological ramifications of subluxation intricacies.

The Index to Chiropractic Literature

ICL

A search was made of the *Index to Chiropractic Literature* and the following entries noted. It can be stated that Chiropractic is a health care profession not just a technique of manipulation. As such, these figures relate to Chiropractic management of a case and not necessarily just manipulative care.

Other management may include advice or recommendations on diet, exercise, nutrition, life style, occupations, sports, muscle relaxation techniques, and hobbies. (Berkson, 1991)

This list notes the number of listings for each search term under the search modifiers on the online portal to ICL. This frequency represents over 4,450 acknowledgements of the term '*subluxation*' in Chiropractic. (Extracted Sept 9, 2022)

Frequency of mentions of '*Vertebral Subluxation Complex*':

All fields	197
Key word	129
Article title	35
Abstract/Notes	61

Frequency of mentions of '*Subluxation*':

All fields	1,555
Key word	906
Article title	612
Abstract/notes	960

Facet disturbance

Due to a disturbance of facets through aberrant motion or lack thereof, physical disruption of spinal articular elements may at times be similar to a sprain with damage to connective tissue and microdamage to fibres. It is suggested that this results in excessive activation of sensory endings. At this vertebral level, the nerve roots themselves may also be irritated or compromised.

These neurological elements may also include noxious sensory activation, nociceptive symptoms or direct radicular irritation. (Carrick, 1997; Cramer & Darby1995; Daligadu et al, 2013; Dvořák &, Dvořák, 1988; 2008; Gatterman, 2005; Hauser, 2021; Hawk, 2011; Honda, 1985; King, 2011; Leach, 1994; Seaman et al. 1998; Slosberg, 1988; Vaňásková et al. 2001)

This disruption may be reflected in sensory activation, neural reflexes involving the autonomic nervous system due to the integration of nervous system.

No evidence was found which indicated that the sensory effects of disturbed vertebral articulations would be confined to nociceptive symptoms or only musculoskeletal structures.

The integration of somatic and visceral fibres would suggest a confirmation of a somatic influence on visceral structures.

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Afferent pathoneurophysiology

Using an 'All Fields' key word search of 'afferent', ICL returns over 40 papers on efferent neural activity as it relates to the profession's model of care.

As sensory pathophysiology continues to evolve, Crawford and Carerina note that in mice, there are over 15 subtypes of sensory neurons that innervate the skin. They suggest the possibility of diverse noxious input may then have different roles in pathologic mechanisms underlying altered sensation and advance the fields of neuropathology. (Crawford & Carerina. 2020)

Consistent with medical research protocols, considerable somatosensory research has been conducted on animals with the extension of this to human physiology appearing to be appropriate. Sato et al (1997) have conducted far-reaching research in this area. It may be noted that if a somato-sensory-autonomic association was disproved, such concepts would be rejected, however, the association appears to be well established. (See our section on Animal Research) They have made the following observations regarding afferent input:

- '*Noxious joint movement led to pronounced excitation of ICN (inferior cardiac sympathetic nerve) accompanied by increases in blood pressure*.' (p. 137)
- '*This articulo-cardiac sympathetic reflex is undoubtedly involved in the articulo-heart rate response*.' (p. 137)
- '*The articulo-cardiovascular reflex originating in the knee joint was therefore thought to be a supraspinal reflex*.' The knee joint of the rat in this research was inflamed. (p. 137)

In addition, under mechanical stimulation of the spine, Sato et al reported that '*decreases in blood pressure and renal nerve activity during manipulation of the spine are thought to be supraspinal reflexes*.' (p. 138)

They also noted that under vertebral joint stimulation of lateral stress of the T10-13 or L2-5 '*produced clear and consistent decreases in blood pressure and renal nerve activity*'. (p. 231 - 3)

Also noted by Savenko, Sato et al state that '*This stimulation of the appropriate segmental spinal nerves does indeed elicit spinally mediated autonomic responses, and these responses, rather than being broad and generalised, are most likely to be specific for organs served by the local autonomic efferents*.' (Sato A & Schmidt,1997, p. 261; Sayenko et al, 2015)

'*It is now clear that there are a multitude of reflex responses of visceral function following somatic afferent stimulation.*' (Sato & Schmidt;1997, p. 258)

'These are quite exciting findings, since the existence of spinal centres for somato-autonomic reflexes had been denied until quite recently.' (Sato & Schmidt;1997, p. 259)

Using anaesthetised animals to eliminate emotional factors, this Sato volume noted that Kimura et al also succeeded in demonstrated that somatic afferent stimulation produces a reflex effect on immune function, with autonomic nerves acting as the efferent pathway. (Kimura et al, 1994, p.254)

Extended reference compilation

Afferent Pathoneurophysiology

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Somatosensory

Schmidt opens his dissertation on sensory afference with a rather definitive declaration:

> '*Activation of somatosensory receptors produces not only conscious sensations but also physiological responses. These bodily responses engage the skeletomotor, autonomic, endocrine and immune systems as well as other organ systems.*' (Schmidt, 2015)

Potentially one of the key etiological elements of the vertebral subluxation complex, a noxious somatosensory activation is the initial phase leading to autonomic, vascular and visceral links in the reflex arcs. As an afferent arc, it is also involved in the withdrawal reflex which is an efferent or motor response.

The senses of conscious awareness are pain, temperature, pressure, light, touch, proprioception, motion, and vibration. In addition to physiological tonus, these can become nociceptive or warning mechanisms of potential insult or damage. Noxious activation of the first three would be common symptoms to be presented under the health sciences. Hyperstimulation or chronic somatosensory afferent input would apply when they arise from sensitive

articulations, muscles, tendons, ligaments, skin and fascia, particularly from the spine. (Physiopedia, undated; Sung et al, 2005; Gieveckas-Martens et al, 2013; Derderian et al, 2022; Raju & Tadi,. 2022)

In citing Woller et al, (2017) Armstrong and Herr (2022) report '*The moderately high-frequency stimulus increases the magnitude of depolarization by maintaining the nerve fiber in a state of partial depolarization; the membrane potential is much closer to the threshold for depolarization than the normal resting potential*'. Thus, each subsequent stimulus depolarises the membrane to a greater extent than the last. The greater the depolarisation, the more local voltage-gated sodium channels get recruited, and the intensity of the afferent action potential generated becomes greater. It is suggested here that such a pathophysiological state continues through to the associated autonomic reflex arcs. (Woller et al, 2017; Armstrong & Herr, 2022)

Extensive neurophysiological research on somato-sensory-visceral influence has been published by Sato and colleagues involving animal subjects. They specifically postulate on the possible role of spinal manipulation and noxious somatosensory reflexes in association with pathophysiological autonomic visceral system. (Sato et al, 1997 pp. 1-2, 138, 231, 258)

Earlier, Schultz et al identified a region in the reticular formation where discharge patterns of somatosensory input influenced cardiorespiratory functions. They concluded '*that in this part of the reticular formation different types of functional organization of the neuronal network are possible. The type of functional organization depends on the actual preponderances of different inputs to the neurons.*' (Schulz et al, 1983)

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Somatosensory with subluxation

Under this VSC model the noxious somatic factor is primarily the vertebral subluxation. In relation to lower back pain, Finneson (1980) stated that a clinical finding associated with facet dysfunction is acute tenderness to pressure over the affected facet. Sometimes this pressure will not only reproduce pain within the back but also aggravate extension of the pain into the lower extremity.

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Somatosensory reflex including referred pain syndromes

Apart from the rather common somato-somatic patella reflex, a somewhat different sensory reflex arc originating with a noxious somatic subluxation may refer symptoms such as pain or paresthesias to other segmentally-related somatic structures. Such a reflex response may contract the intrinsic spinal muscles creating a functional subluxation.

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Somatosensory as pain

Pain or degrees of it may be considered protopathic sensations. It is one of the more common noxious sensory symptoms and diagnostic guides presented in manual healing sciences. As an

afferent sensation, pain may be described as an ache, sharp, stabbing, throbbing, or tenderness, and may institute plastic changes in the cortex. (Gustin et al, 2012; Donnelly, 2017)

It is acknowledged that pain, particularly chronic pain can affect one's quality of life, health status and work productivity. (Elliott et al, 2004; Blyth et al, 200; Kawai et al, 2017; McKillop et al, 2017)

Nociceptors, like other somatovisceral sensory receptors, have their cell bodies in dorsal root (or cranial nerve) ganglia (Willis & Westlund, 2004)

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Chronic pain

Apart from pain attributed to recent onsets, chronic pain has distinct clinical features on presentation. In relation to the spine, it extends to a further example of somato-autonomic and somatovisceral influence as well as biopsychosocial aspects. This may be described as an influence on somatovisceral health.

In relation to the physiology of pain, a relationship would appear with mechanical spinal pain and other system functions. As the recognised benefits of spinal manipulation of biomechanical lesions appears to have positive outcomes, a logical extension of this is that manipulation of spinal lesions may alleviate some visceral conditions by the removal or reduction in pain. (Gureje et al, 1998; Elliott et al, 2004; Pfingsten et al, 2004; Peters et al, 2005; Raffaeli & Arnaudo, 2008; van Oosterwiik et al, 2013; Petri et al, 2013; Fong & Shug, 2014; Jafari et al, 2017; Sylwander et al, 2020; Dobson et al, 2022; Dydyk et al, 2022; Gazi et al, 2022)

As the effect of chronic pain can be so wide, there would appear to be logical reason to take advantage of manipulative means as one of the models in the alleviation of chronic pain where appropriate. (Raffaeli & Arnaudo, 2017; Bonezzi et al, 2012; Siddall & Cousins, 2004)

It is noted that '*Chronic pain exerts an enormous personal and economic burden, affecting more than 30% of people worldwide according to some studies*.' (Cohen et al, 2021)

Such effects include potential influence upon:

- Health (Kawai et al, 2017; Torrance et al, 2010)
- Quality of life (QoL) (Grinberg et al, 2021; Dvdvk & Conermann, 2022; Hadi et al, 2019)
- Physiology of pain (Aronoff, 2015; Woolf & Doubell, 1994)
- Psychology and biopsychosocial ramifications (Cohen et al, 2021; Driscoll & Kerns, 2016)
- Work (Patel et al, 2012; van Leeuwen et al, 2006; Adams & Salomons, 2021; Ransom et al, 2022)
- Pathology (Fine, 2011; Guerreiro et al, 2022; Jänig, 1995; Cervero, 1983)
- Medication side effects (Martel et al, 2015; Carter et al, 2014; Berrymin et al, 2008, Preuss et al 2022)

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Viscerosomatic reflex

Including viscerocutaneous reflex

Sensitization of sensory pathways by inflammation or NGF contributes to the development of hypersensitivity in neighbouring organs and cutaneous referral sites and provides a potential mechanism underlying the coexistence of pain syndromes in patients with functional diseases. (Bielefeldt et al, 2006)

Viscera may refer symptoms with cardiac angina being a classic example. The splinting of abdominal muscles with acute appendicitis may be another. It is suggested that the intrinsic muscles of the spine may similarly become hypertonic and tend to lock the corresponding segment as in a fixation subluxation. (Arendt-Nielsen et al, 2007) We suggest that a vertebral adjustment at an involved segmental level may well interrupt an associated pathological reflex.

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Sensory - proprioception

Some proprioception disturbances have been found to be associated with mechanical disturbances particularly of the cervical spine. The ICL lists over 100 studies involving proprioception in an 'all fields' search. Testing for coordination, positioning, kinesthesia and perception tests are readily implemented in practice.

Aberrations in eye-hand coordination, lower limb coordination and body sway can indicate other forms of disturbed proprioception.

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Somatosensory - pruriception (itching)

Superficial itching can be one of the somatosensory symptoms noted in association with subluxations. Wang et al studied the sensory mechanism of itching and stated '*Chronic pruritus is a symptom that commonly observed in neurological diseases. It has been hypothesized that the chronic pruritus may result from sensitization of itch-signalling pathways but the mechanisms remain obscure*.' As this sensation is sometimes associated with vertebral disturbances it is recognised here. (Ringkamp & Meyer, 2014; Schmelz, 2019; Wang et al, 2021)

While there are a number of causes of paresthesias, an accurate segmental diagnosis is critical when it is suspected of being vertebrogenic in origin. (Mouchette, 1975)

Other paresthesias include numbness, tingling, prickling and burning.

Extended reference compilation

Somatosensory – Pruriception

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Central sensitisation

Processing of somatosensory input

Central Sensitisation Nociception is described by *The International Association for the Study of Pain* (IASP) as the neural process of encoding noxious stimuli. Central sensitisation is defined as an increased responsiveness of nociceptors in the central nervous system. IASP defines the activation of central sensitisation as '*increased responsiveness of nociceptive neurons in the CNS to their normal or subthreshold input.*' (Cayrol & van den Broeke, 2021)

Srbely and colleagues reported that '*neurosegmentally distributed skin temperature changes after experimental induction of central sensitization (offered) support to the theory that central sensitization may be a contributing physiologic mechanism in the clinical expression of somatoautonomic responses in humans*'. (Srbely et al, 2017)

Relative to noxious somatosensory input, in 2008, D'Mello and Dickerson made the following observations in the abstract of their review:

> '*The spinal cord is the first relay site in the transmission of nociceptive information from the periphery to the brain. Sensory signals are transmitted from the periphery by primary afferent fibres into the dorsal horn of the spinal cord, where these afferents synapse with intrinsic spinal dorsal horn neurones. Spinal projection neurones then convey this information to higher centres in the brain, where non-noxious and noxious signals can be perceived. During nociceptive transmission, the output of the spinal cord is dependent on various spinal mechanisms which can either increase or decrease the activity of dorsal horn neurones.*
>
> *Such mechanisms include local excitatory and inhibitory interneurones, N-methyl-D-aspartate receptor activation, and descending influences from the brainstem, which can be both inhibitory and excitatory in nature. After nerve injury or conditions of inflammation, shifts can occur in these excitatory and inhibitory mechanisms which modulate spinal excitability, often resulting in the heightened response of dorsal neurones to incoming afferent signals, and increased output to the brain, a phenomenon known as central sensitization.*' (D'Mello & Dickenson, 2008)

Extended reference compilation

Central Sensitisation

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Brain

Processing of somatosensory input

Activated input from a range of sensory receptors reach the *postcentral gyrus*, *thalamus*, cerebellum, or somatosensory cortex regions of the brain via dorsal root ganglia and their particular spinal tract, depending on which sensation is activated. Here they are processed and integration with the central nervous system as an efferent response. The initiators may be nociceptors, thermoreceptors, chemoreceptors, proprioceptors, and mechanoreceptors. (Gleveckas-et al, 2013; Davis, 2016; Raju & Tadi, 2022)

By employing transcranial magnetic stimulation, Dishman et al (2002) and others measured central cortical spinal activation through lumbar spinal manipulation as a distinct neurophysiologic response involving brain connectivity. (Dishman et al, 2002; Fryer & Pearce, 2012; Gay et al, 2014)

'*Activation of nociceptive somatic afferents excites hypothalamic neurosecretory cells and stimulates the release of vasopressin*.' (Day & Sibbald, 1990)

Extended reference compilation

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To be continued

This series will continue as Part 4 by reporting evidence supportive of Principle 3, that '*neural disturbance may lead to symptoms and at times alter physiological functions of innervated structures such as skeletal muscles, vascular smooth muscles, sphincters, and organs*'.

We consider this principle critical to understanding the *Vertebral Subluxation Complex*.

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See also

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