



## Short Communication

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# Proposed Neurobiological Processes Associated with Models of Vertebral Subluxation: Dysafferentation, Dyskinesia, Dysponesis, Dysautonomia, Neuroplasticity and Ephaptic Transmission

Christopher Kent\*

Director of Evidence-Informed Curriculum and Practice, USA

**\*Corresponding author:** Christopher Kent, Director of Evidence-Informed Curriculum and Practice, Sherman College of Chiropractic, Spartanburg, South Carolina, USA.

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## Abstract

Vertebral subluxations are changes in the position or motion of a vertebra, which result in the interference with nerve function. This paper describes possible neurobiological mechanism associated with vertebral subluxations. These mechanisms include dysafferentation, dyskinesia, dysponesis, dysautonomia, neuroplasticity and ephaptic transmission.

**Keywords:** Vertebral subluxation; Dysafferentation; Dyskinesia; Dysponesis; Dysautonomia; Neuroplasticity; Ephaptic transmission; Chiropractic

## Introduction

Vertebral subluxations are changes in the position or motion of a vertebra, which result in the interference with nerve function [1]. As Lantz [2] noted, "Common to all concepts of subluxation are some form of kinesiologic dysfunction and some form of neurologic involvement." According to Stephenson's 1927 definition [3], vertebral subluxation is: "the condition of a vertebra that has lost its proper juxtaposition with the one above the one below, or both; to an extent less than a luxation; which impinges nerves and interferes with the transmission of mental impulses."

In clinical practice, conceptual definitions, such as those described above, must give rise to operational definitions. An operational definition is a description of the procedures used to determine the means for measuring or observing something [4]. Smith et al. stated, "The potential exists for subluxation resolution to be conceptualized as a legitimate intermediate health outcome, pending the development of a sufficient and requisite body of scientifically derived clinical evidence [5]. This body of evidence must, by necessity, include [1] scientifically valid and reliable measures of subluxation, in order to [2] scientifically examine the

relationship between a patient's subluxation and that patient's health".

The author has proposed an operational model for the assessment of neurological dysregulation associated with vertebral subluxation [6]. The four components of this model are dysafferentation, dyskinesia, dysponesis, and dysautonomia. In the context of dysafferentation, neuroplasticity may be considered. In addition to these mechanisms, non-synaptic communications are potentially affected by vertebral subluxations.

## Discussion

Physical mechanisms associated with signaling in the human body

Hewitt [7] proposed a classification of physical mechanisms associated with signaling in the human body:

1. Diffusion of particles along concentration gradients. This would include processes associated with membrane potentials and ionic exchange.

2. Diffusion of quanta along electromagnetic gradients. These processes are associated with electrical potentials and fields, and include EEG, ECG, EMG, and field effects of ephaptic transmission.

3. Circulation within structured channels. Examples include blood, lymph, cerebrospinal fluid [CSF] and axoplasmic flow.

4. Wave propagation. Longitudinal and transverse waves, as seen in vibratory sense, audition, and soliton waves.

These physical mechanisms are operative in both linear, synaptic processes and nonlinear, nonsynaptic processes.

### Dysafferentation

The intervertebral motion segment is richly endowed with nociceptive and mechanoreceptive structures [8-13]. As a consequence, biomechanical dysfunction caused by vertebral subluxation may result in altered nociception and/or mechanoreception. Aberrant afferent input to the CNS may result in qualitatively and/or quantitatively inappropriate responses to changes in the internal or external environment. This is known as dysafferentation [14].

Himes and Peterson [15] proposed the concept of a “neural image,” dependent upon the integrity of neural receptors and afferent pathways. This “neural image” is a representation of the organism’s perception of the external and internal environment. If afferent input is compromised, efferent response may be qualitatively and quantitatively compromised.

### Neuroplasticity

The clinical implications of aberrant or suboptimal afferent go beyond short-term homeostatic regulation. Dysafferentation may result in anatomical and functional changes in the brain itself. Merzenich, quoted in Holloway stated, [16] “The brain was constructed to change.” This challenge to the conventional world view that the mature adult brain is stable and unchanging, the only exception being the death of brain cells, has profound clinical implications.

Furthermore, Holloway explained how the brain reconfigures itself and the implications of doing so: “Change the input, be it a behavior, a mental exercise ... or a physical skill and the brain changes accordingly. Magnetic resonance imaging machines reveal the new map: different regions light up ... The brain can be extensively remodeled throughout the course of one’s life, without drugs, without surgery. Regions of the brain can be taught to do different tasks if need be ... This sort of thing will be a part of normal future life ... healing plasticity can be driven by behavior.”

Gage [17] wrote, “Researchers first demonstrated that the central nervous systems of mammals contain some innate regenerative properties in the 1960s and 1970s, when several groups showed that axons, or main branches, of neurons in the adult brain and spinal cord can regrow to some extent after injury.” The ability of the brain to change both anatomically and functionally

is known as neuroplasticity. Clifford [18] described three types of plasticity:

- Experience-independent plasticity refers to changes which are not the result of environmental changes or influence.
- Experience-expectant plasticity occurs when the brain uses input from the external environment to effect normal developmental changes in its structure.
- Experience-dependent plasticity is when a modification to the internal or external environment produces change in a feature of the brain.

However, not all neuroplastic changes are favorable. It has been hypothesized that maladaptive neuroplastic changes may be associated with vertebral subluxations [19].

### Dyskinesia

Dyskinesia refers to distortion or impairment of voluntary movement [20]. Spinal motion may be reliably measured using inclinometry [21]. Alterations in regional ranges of motion may be associated with vertebral subluxation [22].

### Dysponesis

Dysponesis is evidenced by abnormal tonic muscle activity. Dysponesis refers to a reversible physiopathologic state consisting of errors in energy expenditure, which is capable of producing functional disorders. Dysponesis consists mainly of covert errors in action potential output from the motor and premotor areas of the cortex and the consequences of that output. These neurophysiological reactions may result from responses to environmental events, bodily sensations, and emotions. The resulting aberrant muscle activity may be evaluated using surface electrode techniques [23]. Typically, static SMEG with axial loading is used to evaluate innate responses to gravitational stress [24]. Surface EMG procedures are reliable [25].

### Dysautonomia

The autonomic nervous system regulates the actions of organs, glands, and blood vessels. Acquired dysautonomia may be associated with a broad array of functional abnormalities [26-31]. Sympathetic tone may be evaluated by measuring skin temperature differentials using paraspinal infrared thermography [32]. Such techniques have been used to monitor changes in neurological function associated with vertebral subluxations [33] and are reliable [34]. Heart rate variability is a reliable and valid technique for the assessment of changes in autonomic nervous system function [35,36].

### Ephaptic Transmission

Ephaptic transmission occurs when electric fields activate neighboring cells without synaptic transmissions or gap junctions [37]. Boone and Dobson [38] discussed mechanisms of non-synaptic transmission, including ephaptic coupling, as a mechanism which may be affected by vertebral subluxation. However, technology to assess this phenomenon clinically is lacking, and the role of

ephaptic transmission in cases of vertebral subluxation remains speculative.

## Conclusion

Correction or reduction of vertebral subluxation facilitates the restoration of proper tone throughout the nervous system. Alterations in the tone of the somatic system may be objectively evaluated using surface EMG. Altered autonomic tone may be evaluated using skin temperature measurements. Changes in ranges of motion may be measured to assess dyskinesia. Such objective assessments have the potential to make correction of vertebral subluxation an important strategy in salutogenic healthcare. Additional research in this area may lead to improved clinical strategies.

## Acknowledgment

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## Conflict of Interest

No conflict of interest.

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