Asia-Pacific Chiropractic Journal

eBOOKCHAPTER

Introduction to Chiropractic Manipulative Reflex Technique (CMRT)

(Chapter 5)

Charles L Blum

Chapter 5

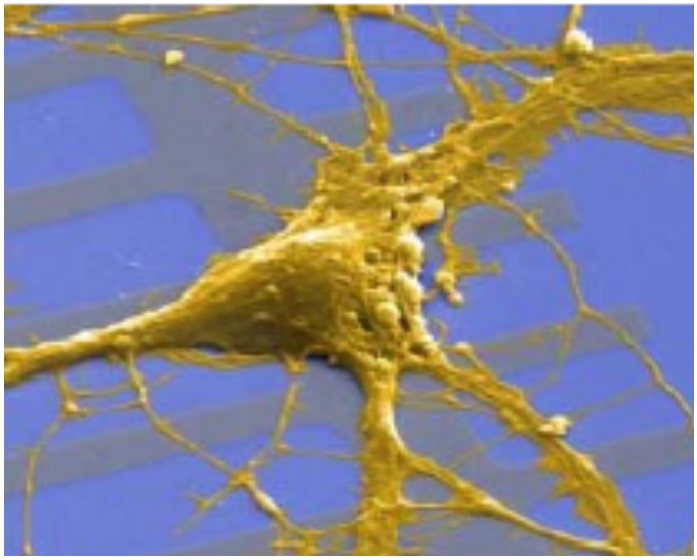
Non-Synaptic Messaging and Nonmusculoskeletal Conditions

There are many mysteries about chiropractic care for nonmusculoskeletal conditions. While some factions of the chiropractic profession want to eliminate chiropractic care for nonmusculoskeletal conditions, (1) other researchers report, "*the current evidence suggests that more research on nonmusculoskeletal conditions is warranted before any definitive conclusions can be made. Governments, insurers, payers, regulators, educators, and clinicians should avoid using systematic reviews in decisions where the research is insufficient to determine the clinical appropriateness of specific care*." (2) Besides Goertz, et.al. questioning the over interpretation of limited research data on chiropractic care of nonmusculoskeletal conditions, a number of other renown chiropractic academics are reaching the same conclusion. (3-11)

What is confounding about chiropractic treatment of nonmusculoskeletal conditions is that viscerosomatic and somatovisceral referred pain is very complex and often diffuse. What might cause a presenting symptom with one patient may not be present with another. While we see research demonstrating chiropractic having a positive effect with a patient's nonmusculoskeletal condition, (12-15) we cannot reliably state that research has figured out what subset of patients with nonmusculoskeletal conditions might best respond to a specific chiropractic intervention. Therefore, greater research is needed to unravel this chiropractic and nonmusculoskeletal clinical tapestry. Hopefully, Chiropractic Manipulative Reflex Technique (CMRT) assessment and care will enhance understanding on how to render chiropractic care for patients seeking help for nonmusculoskeletal presentations in a consistent and effective manner.

Some chiropractic techniques systems have sought to better understand chiropractic's effect on nonmusculoskeletal conditions and often looked to autonomic nervous system imbalance as well as viscerosomatic and somatovisceral referred pain and/or reflex altered activity. Another possible relationship not commonly discussed regarding a relationship between

nonmusculoskeletal care and chiropractic might involve non-synaptic messaging. (16)



Communication within the nervous system is commonly accepted to take place at a synapse, which is the junction where two or more nerves come into proximity of one another. The region of a synapse communication between nerves is usually maintained by the exchange of neurotransmitters or electrical charges. "*The discovery of nonsynaptic communication in the 1960s and 1970s was an important milestone in investigating the function of the nervous system, and it revolutionized our view about information transmission between neurons. In addition, nonsynaptic communication has a practical importance not only within the nervous system, but in the communication between the peripheral nervous system and other organ systems*." (17)

Viscerosomatic, somato-somatic, and sclerotomal reflexes have pain patterns that are generally of a diffuse nature and can possibly be attributed to a form of nonsynaptic messaging. Since chiropractors are often treating pain syndromes of a diffuse nature, the relationship of non-synaptic messaging to manipulation may be of value. There are various classes of nonsynaptic interactions that include but are not limited to:

- Electrotronic (and Chemical) Coupling Through Gap Junctions
- Ephaptic Transmissions
- Field Effect Interactions
- Fluctuations In Extracellular Ions
- Glial Cell Messaging and CSF
- Piezoelectric/Mechanoelectric Effect
- Low Level Electromagnetic Fields and Neuromelanin
- Quantum Tunneling

Gap junctions are specialized areas of the cell membranes that connect neighboring cells. "*They are organized collections of protein channels that allow ions and small molecules (below 1000 daltons molecular weight) to traverse between the connected cells in a passive fashion*." (18)

Ephaptic transmission is mediated by electrical coupling between specific neuronal elements in the absence of specialized neuronal contacts such as synapses. The original use of "*ephaptic*" referred to two axons or other neuronal processes so close together that the current produced by one has a major effect on the adjacent one; the location of this close proximity could then be called an "*ephapse*" (a similar concept to the "*synapse*" where close proximity allows neurotransmitters to diffuse from the presynaptic neuron to the postsynaptic neuron). "*Field effects are diffuse and rely more on the common orientation of a neuronal population causing the current density and field strength to build up sufficiently to have an impact on neuronal function.*" (19)

Field effect interactions are mediated by large extracellular currents and potential fields generated by cortical structures. Endogenous and applied electric fields interactions can alter neuronal excitability at field strengths over a few millivolts per millimeter. (19)

Fluctuations in extracellular ions such as K+ are released during neuronal activity and theses extracellular fluctuations can alter neuronal excitability. [1] Clinically, "*field effects and ion fluctuations probably have modest effects during physiological activity but have a significant impact [for instance] on epileptic seizures, and can sustain them in the absence of synaptic transmission*." (19)

Glial Cell Messaging and CSF

In the chiropractic and osteopathic fields, practitioners utilizing cranial manipulative therapies discuss a concept entitled the "*Primary Respiratory Mechanism*." (20, 21) This mechanism postulates that neural tissue rhythmic pulsation is independent of cardiac or respiratory influences. It is possible that this neural rhythmic pulsation may be a type of nonsynaptic messaging. (22, 23)

A 2004 study found that a "*system of cerebrospinal fluid (CSF)-contacting neurons seems to have a special role in taking up, transforming and emitting nonsynaptic signals mediated by the internal and external CSF and intercellular fluid of the brain.*" (24) Coupled with the possible nonsynaptic activity within the CSF, glial cells have also been found to be associated with nonsynaptic activity and glutamate production. Other than in the CSF, there is evidence that nonsynaptic glutamate exists within the extracellular fluid, released from glial cells, which may act on extrasynaptic glutamate receptors of cells located far from the position where it is released. (25)

Piezoelectric/Mechanoelectric Effect

Is there a relationship between the nonsynaptic field effects and mechanoelectric properties of stressed osseous structures? It does appear that stressed connective tissue responds with mechanoelectric activity, often considered related to a piezoelectric effect. (26, 27)

Bassett performed an extensive review of the biological significance of piezoelectricity, noted that, "*major emphasis has been placed on the origin and possible effects of piezoelectric phenomena in bones. It is evident, however, that piezoelectricity is present in many, if not all, biologic systems*." (28)

Bassett continues, "*Mechanical energy expended in these structures can produce electric potentials of sufficient magnitude to exert a wide range of effects in living systems. These include, theoretically, control of cell nutrition, local pH control and enzyme activation or suppression, orientation of intra- and extra-cellular macromolecules, migratory and proliferative activity of cells, synthetic capability and specialized function of cells, contractility and permeability of cell membranes and energy transfer*." (28)

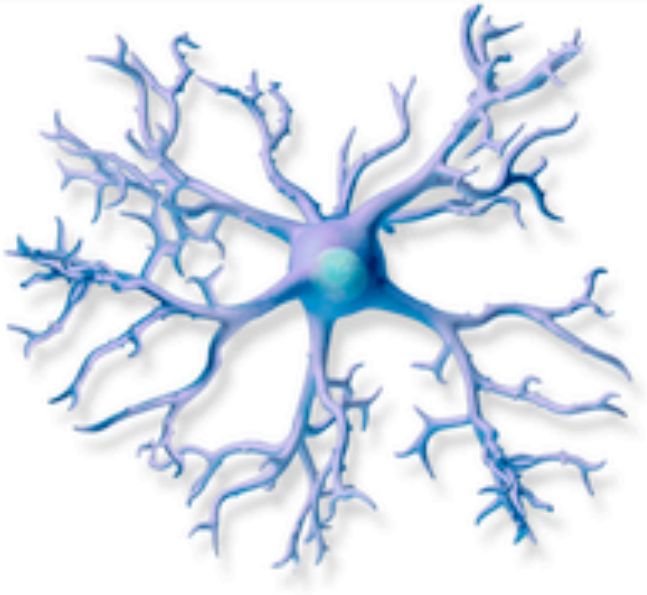
Low Level Electromagnetic Fields and Neuromelanin

In a book edited by Adey and Lawrence entitled *Nonlinear Electrodynamics in Biological Systems*, extensive information is shared on low-level electromagnetic fields and their effect on living tissues, as well as their bioelectric and electrochemical behavior. (29) The research presented in this book is derived from the proceedings of a 1983 international conference on "*Nonlinear Electrodynamics in Biological Systems*," held in Loma Linda, California. Presentations at this conference by many independent researchers demonstrated that low-level electromagnetic fields have a profound effect on biological systems.

While nonsynaptic messaging was not discussed at the conference, in a parallel study Adey found that "an intercellular communication based on low frequency oscillation is a clear possibility. The extra-cellular medium is an efficient conductor at low frequencies and may behave in a frequency dependent manner in the counterion layer adjoining the membrane surface. Leakage of low frequency membrane potential oscillations into the extra-cellular space

has been extensively described and plays a prime role in brain tissue in the genesis of the EEG." (30) Adey noted that the piezoelectric activity occurring in stressed connective tissue is approximately a thousand times stronger than that of the electromagnetic fields studied at the conference in Loma Linda, California. (31)

This mechanoelectric activity takes on a greater significance when relating it to Barr's work with neuromelanin. (32 - 33) Barr has determined that "*melanin transduces both acoustic and electric energy fields and it can generate enough heat to affect metabolic processes*." (32) He noted that in vitro studies have shown that melanin functions as an amorphous semiconductor within physiological ranges of neuronal electrical potentials. (32)



Barr proposed that "*a direct current system (probably produced by the glial perineural network and other strategic melanin loci) regulates the development and growth of embryological and adult tissues, tissue repair and regeneration, and numerous other organizational mechanisms*." (32) Barr suggested that there is a relationship between this direct current system and the electroencephalogram (EEG). He stated, "*The production of the spontaneous electrical activity of the EEG is due to cortical dendritic graded processes and/or glial-generated sustained current*." (33)

The key issue with regards to Barr's work and nonsynaptic messaging is that melanin is richly invested in all the neuroglial tissues and is called neuromelanin. The glial cells surrounding neurons and nerve fibers can be generating an electric field at low levels similar to those found in biologic systems by Adey. These electric fields can then permit communication within the body that would not have to pass directly within the nerve tissue or solely at synaptic junctions.

Consistent with Barr and Adey, a 2018 study found that highly pervasive electromagnetic frequency (EMF) "*fluctuations may play an important role in the global integrative actions of the brain; hence, EMF signaling may transcend classical connectionist models of brain function*." (34) Agnati et al, call this new concept "*broadcasted neuroconnectomics*" and purport that it transcends the current connectomics view of the brain. [34]

Quantum Tunneling

Quantum Tunneling is the "*crossing of a membrane by electrons, which can interact and stimulate cellular adaptations without prior excitation of the receptors.*" (35) Every time electrons move and the cell becomes excited, a magnetic field is generated; the change in position or number of electrons generates an electric field, generating an electromagnetic field (36). "*The electromagnetic field expands and moves (electromagnetic wave or electromagnetic frequency/oscillation/vibration) and invades the surrounding area, involving other cells in a cascade, putting the whole body in communication.*" (36, 37) Bordoni and Simonelli note that due to the human body's fluid environment "*the greater the synchronicity of this phenomenon, the greater the cellular functionality; the speed of information transmission is faster than the electrical neural speed*." (38)

Nonsynaptic Transmission and the Autonomic Nervous System

Nonsynaptic transmission may be affecting autonomic nervous system activity since it is characteristic of autonomic neuroeffector junctions. "*The essential features are that: the terminal portions of autonomic nerve fibers are varicose and mobile, transmitters being released 'en passage' from varying distances from the effector cells; while there is no structural post-junctional specialization on effector cells, receptors for neurotransmitters accumulate on cell membranes at close junctions; muscle effectors are bundles rather than single smooth muscle cells, that are connected by gap junctions which allow electrotonic spread of activity between cells. A multiplicity of transmitters are utilized by autonomic nerves, and cotransmission occurs often involving synergistic actions of the cotransmitters, although pre- and post-junctional neuromodulation of neurotransmitter release also take place*." (39)

While synaptic transmission of neural impulses is the most commonly accepted form of communication within the nervous system, nonsynaptic transmission might offer another path for neural messaging. "*The fact that transmitters can even be released from nonsynaptic varicosities without being coupled to frequency-coded neuronal activity and they are able to diffuse over large distances indicates that there is a complementary mechanism of interneuronal communication to classical synaptic transmission*." (40)

Vizi noted that axons are found in both the CNS and autonomic nervous system forming varicose (*boutons-en-passant*) branches. Varicose axon terminals, which in the overwhelming majority do not make synaptic contacts, are the main targets of presynaptic modulation. (41) Vizi followed up the previous study and discovered that neurotransmitters "*released from axon terminals without synaptic contact play an important role in the fine tuning of communication between neurons within a neuronal circuit*." (42)

Vertebra (43) and even cranial bones (44) under stress exhibiting piezoelectric activity might have an affect on local bioelectrodynamics and neurological function. Similar to the way myelin functions to facilitate some nerve transmission, (40) the neuromelanin in the neuroglial tissues might be functioning to facilitate a gross communication neurologically. Piezoelectric or bioelectrodynamics has entered a realm, which to some may seem paranormal. However according to Adey, non-synaptic type activity can be affected "*by highly nonlinear, nonequilibrium processes at critical steps in signal coupling across cell membranes. There is increasing evidence that these events relate to quantum states and resonant responses in biomolecular systems*." (45) This bioelectrical activity is apparently commonplace in human physiological processes at the biomolecular level.

These low level electrodynamic nonsynaptic activities, according to Lawrence and Adey, do not necessarily have to be short-acting neural activities (46). They found that, "*interactions of phonons [a quantum of acoustic energy] and excitons [an elementary excitation of a solid] along linear molecules may produce nonlinear molecular vibrations in the form of soliton waves*." (46) "*Solitons are a quantum of energy or quasiparticle that can be propagated as a traveling wave in nonlinear systems and is neither preceded nor followed by another such disturbance; does not obey the superposition principle and does not dissipate*." (47)

"*Molecules tend to be located within a coordinate frame of their own, their position and orientation are specified by reference to some previously defined coordinate frame*." (46) When molecules are excited in a manner so that they vibrate outside their coordinate frame, they can form solitons, which exist in a minimal energy state and are extremely long-lived in comparison to linear oscillations. "*Solitons may convey energy released by chemical reactions from one site to another in enzymes of other long-chain proteins. These nonlinear waves may also couple reaction-diffusion processes in the intracellular and extracellular domains*." (46) These low-level

electrodynamic activities can have long-term function exceeding their initial propagation and affecting nonsynaptic neural communication.

Future Study

With further investigation into non-synaptic activity, a rational for energetic practices used in various chiropractic methods and other healing disciplines might be uncovered.

Somatovisceral relationships, diffuse neurological syndromes and reflex points on the body unrelated to direct neurological synaptic connections may have some explanation based on the theories presented. Vizi points out that nonsynaptic interneuronal communication "*would be a transitional form between the classical neurotransmission and the broadcasting of neuroendocrine secretion*." (48)

However, at this time nothing conclusive can be drawn from the field effect associated with nonsynaptic messaging. Therefore, practitioners using chiropractic methods such as CMRT, must continue greater investigative study as a means to build understandings about these complex reflex and referred pain relationships.

References

1. Côté P, Hartvigsen J, Axén I, Leboeuf-Yde C, et al. The global summit on the efficacy and effectiveness of spinal manipulative therapy for the prevention and treatment of non-musculoskeletal disorders: a systematic review of the literature. Chiropr Man Therap. 2021 Feb 17;29(1):8.
2. Goertz CM, Hurwitz EL, Murphy BA, Coulter ID. Extrapolating Beyond the Data in a Systematic Review of Spinal Manipulation for Nonmusculoskeletal Disorders: A Fall From the Summit. J Manipulative Physiol Ther. 2021 May;44(4):271-279.
3. Morgan WE. Agenda-Driven Summit. J Manipulative Physiol Ther. 2021 Jul-Aug;44(6):514.
4. Marchiori DM. Overextrapolation, Missed Opportunities, and Ladders on the Wrong Walls. J Manipulative Physiol Ther. 2021 Jul-Aug;44(6):512-513.
5. Sportelli L. Science is Ever Changing. J Manipulative Physiol Ther. 2021 Jul-Aug;44(6):506.
6. Budgell BS. Re. Goertz et al. Extrapolating beyond the data. J Manipulative Physiol Ther. 2021 Jul-Aug;44(6):508-509.
7. Haavik H. Comment about Extrapolating Beyond the Data. J Manipulative Physiol Ther. 2021 Jul-Aug;44(6):511.
8. Scaringe J, Nagare MA, Russell R, Whedon J. Extrapolating Beyond the Data. J Manipulative Physiol Ther. 2021 Jul-Aug;44(6):513-514.
9. Pohlman KA. Support of "A Fall From the Summit" by Goertz et al. J Manipulative Physiol Ther. 2021 Jul-Aug;44(6):510-511.
10. Kopansky-Giles D. Premature evaluation-making policy recommendations in the absence of sufficient evidence. J Manipulative Physiol Ther. 2021 Jul-Aug;44(6):507-508.
11. Haldeman S. SMT and non-MSK disorders: The correct concern but the wrong research question. J Manipulative Physiol Ther. 2021 Jul-Aug;44(6):505.
12. Hawk C, Long CR, Boulanger KT, Prevalence of nonmusculoskeletal complaints in chiropractic practice: Report from a practice-based research program J Manipulative Physiol Ther 2001;24:157-69.
13. Nansel D, Szlazak M.] Somatic dysfunction and the phenomenon of visceral disease simulation: a probable explanation for the apparent effectiveness of somatic therapy in patients presumed to be suffering from true visceral disease. J Manipulative Physiol Ther. 1995 Jul-Aug;18(6):379-97.
14. Leboeuf-Yde C, Pedersen EN, Bryner P, Cosman D, Hayek R, Meeker WC, Shaik J J, Terrazas O, Tucker J, Walsh M, Self-reported Nonmusculoskeletal Responses to Chiropractic Intervention: A Multination Survey J Manipulative Physiol Ther 2005;28:294-302.
15. Leboeuf-Yde C, Axén I, Ahlefeldt G, Lidefelt P, Rosenbaum A, Thurnherr T. The types and frequencies of improved nonmusculoskeletal symptoms reported after chiropractic spinal manipulative therapy. J Manipulative Physiol Ther. 1999 Nov-Dec;22(9):559-64.
16. Blum CL. Non-synaptic messaging: Piezoelecticity, bioelectric fields, neuromelanin and dentocranial implications. J Vert Sublux Res: 2007(JAN:30): Online access only 6 p.
17. Selmeczy Z, Vizi ES, Csóka B, Pacher P, Haskó G. Role of nonsynaptic communication in regulating the immune response. Neurochem Int. 2008 Jan;52(1-2):52-9.

18. Kumar NM, Gilula N. What Is A Gap Junction? Cell. 1996;84:381-388.

19. Jefferys JG. Nonsynaptic modulation of neuronal activity in the brain: electric currents and extracellular ions. Physiol Rev. 1995 Oct;75(4):689-723.

20. Lockwood MD, Degenhardt BF. Cycle-to-cycle variability attributed to the primary respiratory mechanism. J Am Osteopath Assoc. 1998 Jan;98(1):35-6, 41-3. Erratum in: J Am Osteopath Assoc. 1998 Mar;98(3):137.

21. Lee RP. The living matrix: a model for the primary respiratory mechanism. Explore (NY). 2008 Nov-Dec;4(6):374-8.

22. Allen KL, Bunt EA, Podlas H, Slow Rhythmic Ventricular Oscillations and Parenchymal Density Variations Shown by Sequential CT Scanning, University of the Witwatersrand - Johannesburg, School of Mechanical Engineering, Research Report 1983; 83(Feb): 1-36.

23. Feinberg DA, Mark AS, Human Brain Motion and Cerebrospinal Fluid Circulation Demonstrated with MR Velocity Imaging, Radiology, 1987; 163: 793-9.

24. Vigh B, Manzano e Silva MJ, Frank CL, Vincze C, Czirok SJ, Szabo A, Lukats A, Szel A. The system of cerebrospinal fluid-contacting neurons. Its supposed role in the nonsynaptic signal transmission of the brain. Histol Histopathol. 2004 Apr;19(2):607-28.

25. Rodriguez DM, Alonso TJ, Perdomo DJ, Gonzalez HT, Castro FR, Sabate M, Garcia DJ. Glial regulation of nonsynaptic extracellular glutamate in the substantia nigra. Glia. 2005 Jan 1;49(1):134-42.

26. Jacob J, More N, Kalia K, Kapusetti G. Piezoelectric smart biomaterials for bone and cartilage tissue engineering. Inflamm Regen. 2018 Feb 27;38:2.

27. Zaitsev BD, Kuznetsova IE. The energy density and power flow of acoustic waves propagating in piezoelectric materials. IEEE Trans Ultrason Ferroelectr Freq Control. 2003 Dec;50(12):1762-5.

28. Bassett C, Review Biologic Significance of Piezoelectricity Calc. Tiss. Res 1968; 1: 252-72.

29. Adey W, Lawrence A. Nonlinear Electrodynamics in Biological Systems. Plenum Press (New York), 1984.

30. Adey W. Nonlinear Nonequilibrium Aspects of Electromagnetic Field Interaction at Cell Membranes. Nonlinear Electrodynamics in Biological Systems. Plenum Press (New York). 1984: 3-22.

31. Adey W, Personal Communication. January, 1986.

32. Barr F, Melanin The Organizing Molecule. Medical Hypotheses. 1983; 11: 1-140.

33. Barr F, Melanin and the Mind — Brain Problem. Institute for the Study of Consciousness, 2924 Benvendue Ave., Berkeley.

34. Agnati LF, Guidolin D, Maura G, Marcoli M. Functional roles of three cues that provide nonsynaptic modes of communication in the brain: electromagnetic field, oxygen, and carbon dioxide. J Neurophysiol. 2018 Jan 1;119(1):356-368.

35. Tang J, Guo Q, Wu Y, Ge J, Zhang S, Xu H. Light-Emitting Plasmonic Tunneling Junctions: Current Status and Perspectives. ACS Nano. 2024 Jan 30;18(4):2541-2551.

36. Matarèse BFE, Lad J, Seymour C, Schofield PN, Mothersill C. Bio-acoustic signaling; exploring the potential of sound as a mediator of low-dose radiation and stress responses in the environment. Int J Radiat Biol. 2022;98(6):1083-1097

37. Bordoni B, Escher AR, Castellini F, Vale J, Tobbi F, Pianese L, Musorrofiti M, Mattia E. Fascial Nomenclature: Update 2024. Cureus. 2024 Feb 11;16(2):e53995.

38. Bordoni B, Simonelli M. The Awareness of the Fascial System. Cureus. 2018 Oct 1;10(10):e3397.

39. Burnstock G. Non-synaptic transmission at autonomic neuroeffector junctions. Neurochem Int. 2008 Jan;52(1-2):14-25.

40. Reilly JP, Diamant AM Neuroelectric mechanisms applied to low frequency electric and magnetic field exposure guidelines--part II: non sinusoidal waveforms. Health Phys. 2002 Sep;83(3):356-65.

41. Vizi ES. Presynaptic modulation of transmitter release via alpha2-adrenoceptors: nonsynaptic interactions. Acta Biol Hung. 1999;50(1-3):287-95.

42. Vizi ES. Role of High-Affinity Receptors and Membrane Transporters in Nonsynaptic Communication and Drug Action in the Central Nervous System. Pharmacology Reviews. 2000 (Mar); 52(1):63-90.

43. Horst M, Brinckmann P. 1980 Volvo award in biomechanics. Measurement of the distribution of axial stress on the end-plate of the vertebral body. Spine. 1981 May-Jun;6(3):217-32.

44. Blum CL. The effect of movement, stress and mechanoelectric activity within the cranial matrix. Int J Orthod. 1987 Spring;25(1-2):6-14.

45. Adey WR. Biological effects of electromagnetic fields. J Cell Biochem. 1993 Apr;51(4):410-6.

46. Lawrence AF, Adey WR. Nonlinear wave mechanisms in interactions between excitable tissue and electromagnetic fields. Neurol Res. 1982;4(1-2):115-153.

47. Heimburg T. The thermodynamic soliton theory of the nervous impulse and possible medical implications. Prog Biophys Mol Biol. 2022 Sep;173:24-35.

48. Vizi ES. Non-synaptic intercellular communication: presynaptic inhibition. Acta Biol Acad Sci Hung. 1982;33(2-3):331-51.

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About the author

Charles L Blum
DC, CSP, CSCP
Director of Research
Sacro Occipital Technique Organization - USA
Private practice of Chiropractic
Santa Monica, CA

Charles L Blum DC, CSCP is in private practice *Santa Monica, California* and past president of SOTO – USA, now their research chair. He serves as Adjunct research faculty at *Cleveland Chiropractic College* and associate faculty at *Southern California University of Health Sciences* teaching the SOT Elective. Dr. Blum is a Certified SOT Cranial Practitioner, and on the peer review board of the *Journal of Craniomandibular and Sleep Practice* (CRANIO), *Association of Chiropractic College Conference Peer Review Committee*, *Journal of Contemporary Chiropractic*, *Asia Pacific Chiropractic Journal*, and *Journal of Chiropractic Medicine*. He has lectured nationally and internationally, has written various SOT related texts, compiled SOT and cranial related research, and has extensively published in multiple peer reviewed indexed journals and at research conferences from 1984 to the present.