The Scientific Basis for the Salutogenic Management of Vertebral Subluxation

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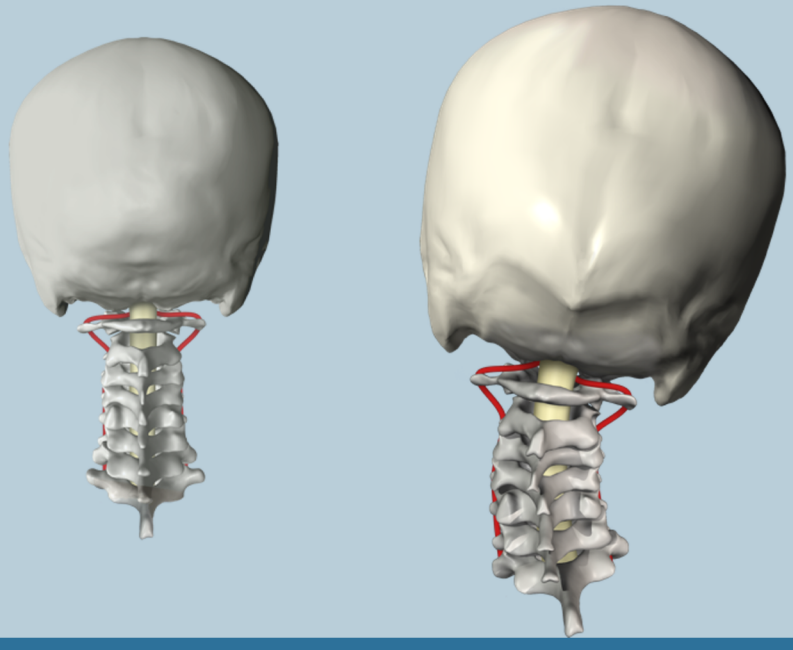

A collection of literature reviews, research articles, case studies and series demonstrating the rationale and scientific support for the the management of vertebral subluxation in chiropractic practice.

The Scientific Basis for the Management of Vertebral Subluxation in a Salutogenic Model

Steve Tullius, D.C., ACP

Every scientist, mechanic, architect and engineer understands that structure always affects function.

Whether it's a bridge, home, skyscraper or vehicle, if the structural integrity is distorted or altered, so is the safety, stability and function.

Our bodies are no different in that regard.

Structural tensions and distortions in the body necessarily result in unwanted physical changes. These structural distortions occur commonly in the spine and are known as vertebral subluxation. When present, these spinal misalignments have a negative impact on neurophysiology and therefore health.

This document serves as a collection of evidence documenting these effects and is by no means a complete list.

It is a collection of systematic reviews, research articles and case reports or series that have been grouped together by the subject matter. It is the beginnings of an in-depth paper on the topic.

As you review this, you will soon notice that many of the papers have been released in the past five years. This is a testament to the ever-growing body of knowledge and reminder that what we don't know is often far greater than what we do.

I hope this document serves as a valuable tool to aid in the evolution and advancement of our thinking and knowledge on the topic and ultimately to more people achieving their optimal health and potential.

Steve Tullius, D.C., ACP

Introduction

This document is divided into 5 main sections that present the scientific papers demonstrating the rationale, evidence and appropriateness for salutogenic chiropractic care for individuals of all ages regardless of the presence of symptoms or disease processes.

When discussing chiropractic care, it is essential to discuss the health care paradigms of salutogenesis and pathogenesis.

The salutogenic model focuses on factors that support the health, well-being and resilience of the individual, while the pathogenic model focuses on factors that cause disease.

Chiropractic care has long been centered in the salutogenic model of healthcare far before the term salutogenesis was even coined.

The error many individuals, researchers and legislators as well as licensing bodies make is trying to place chiropractic care in the pathogenic model when the very existence of the profession legally rests in most jurisdictions as being a separate and distinct healing approach.

To limit chiropractic to the treatment of musculoskeletal conditions is not supported by the basic sciences or evidence currently available and constitutes a willful or unwittingly simple ignorance of the literature shared below.

The 5 Premises of Salutogenic Management of Vertebral Subluxation:

1. Chiropractic falls under a salutogenic model of healthcare which focuses on approaches that support health and well-being rather than the pathogenic model which focuses on factors that cause disease.

2. Dysautonomia (autonomic nervous system dysfunction / dysregulation) causes degenerative neurophysiological cascades and negative overarching health consequences.

3. Interventions that address the autonomic nervous system produce positive physiological and health outcomes.

4. Improper biomechanics of the spine and associated craniofacial structures as well as postural distortions negatively effect neurophysiology, health, and quality of life.

5. Adjusting subluxated vertebrae is exceedingly safe and has positive neurophysiological, health and quality of life outcomes.

Premise #1: Salutogenic Model of Healthcare

The salutogenic model of healthcare focuses on factors that contribute to and support optimal health and well-being and not factors that cause disease. The chiropractic management of vertebral subluxation resides within the salutogenic model and does not claim to treat disease which is the practice of medicine.

Kent, C. "Chiropractic and Mental Health: History and Review of Putative Neurobiological Mechanisms." *Jou Neuro Psy An Brain Res: JNPB-103* (2018).

> *"Chiropractic care incorporates a salutogenic approach. Sociologist Aaron Antonovsky coined the term salutogenesis in 1979. It is derived from salus, Latin for health, and genesis, meaning to give birth. Salutogenesis, the study of the origins and creation of health, provides a method to identify an interconnected way to enhance well-being. Salutogenesis provides a framework for a method of practice to promote health. Salutogenic theory goes to the very essence of neurobiology. It has been noted that neurological processes (as well as anatomical structures) are remodeled by sensory input. These processes, collectively termed neuroplasticity, are operative at all levels of the nervous system."*

Antonovsky, Aaron. "The salutogenic model as a theory to guide health promotion." *Health promotion international* 11.1 (1996): 11-18.

Eriksson, Monica, and Bengt Lindström. "Antonovsky's sense of coherence scale and the relation with health: a systematic review." *Journal of epidemiology & community health* 60.5 (2006): 376-381.

Jonas, Wayne B., et al. "Salutogenesis: the defining concept for a new healthcare system." *Global advances in health and medicine* 3.3 (2014): 82-91.

Premise #2: Dysautonomia (autonomic nervous system dysfunction / dysregulation) causes degenerative neurophysiological cascades and negative overarching health consequences.

The nervous system is the master system of the body. It controls and coordinates all actions of the body and strives to maintain a living thing in active organization. Specifically, the autonomic nervous system is most intimately involved in these processes.

Dysautonomia, or autonomic nervous system dysfunction/dysregulation, is associated with and contributes to multiple degenerative somatic and neurocognitive conditions.

Scientific Basis:

Wulsin, Lawson, James Herman, and Julian F. Thayer. "Stress, autonomic imbalance, and the prediction of metabolic risk: A model and a proposal for research." *Neuroscience & Biobehavioral Reviews* 86 (2018): 12-20.

> *"Our review of eleven prospective human studies shows substantial evidence that autonomic dysregulation precedes and promotes the development of multiple metabolic risks and disorders."*

Vigo, Daniel E., Leonardo Nicola Siri, and Daniel P. Cardinali. "Heart Rate Variability: A Tool to Explore Autonomic Nervous System Activity in Health and Disease." *Psychiatry and Neuroscience Update*. Springer, Cham, 2019. 113-126.

> *"The autonomic nervous system (ANS) is structural and rhythmically interfaced between forebrain, internal, and external environments, to regulate energy, matter, and information exchanges, thus expressing the biopsychosocial nature of the individual."*

> *"In addition, autonomic imbalance may configure a final common pathway to increased morbidity and mortality from a host of physical, such as metabolic disorders and cardiovascular disease, and psychological conditions, like anxiety or depression."*

Licht, Carmilla MM, Eco JC de Geus, and Brenda WJH Penninx. "Dysregulation of the autonomic nervous system predicts the development of the metabolic syndrome." *The Journal of Clinical Endocrinology & Metabolism* 98.6 (2013): 2484-2493.

> *"Increased sympathetic activity predicts an increase in metabolic abnormalities over time. These findings suggest that a dysregulation of the autonomic nervous system is an important predictor of cardiovascular diseases and diabetes through dysregulating lipid metabolism and blood pressure over time."*

Lemche, Erwin, Oleg S. Chaban, and Alexandra V. Lemche. "Neuroendorine and epigentic mechanisms subserving autonomic imbalance and HPA dysfunction in the metabolic syndrome." *Frontiers in neuroscience* 10 (2016): 142.

"There is increasing evidence for autonomic imbalance in metabolic syndrome, the exact nature of this sympathetic hyperexcitability appearing to have primarily consequences for the development of obesity and insulin resistance."

Thayer, Julian F., and Esther Sternberg. "Beyond heart rate variability: vagal regulation of allostatic systems." *Annals of the New York Academy of Sciences* 1088.1 (2006): 361-372.

"Decreased vagal function and heart rate variability (HRV) were shown to be associated with increased fasting glucose and hemoglobin A1c levels, increased overnight urinary cortisol, and increased proinflammatory cytokines and acute-phase proteins. All of these factors have been associated with increased allostatic load and poor health. Thus, vagal activity appears to play an inhibitory function in the regulation of allostatic systems. The prefrontal cortex and the amygdala are important central nervous system structures linked to the regulation of these allostatic systems via the vagus nerve."

Wulsin, Lawson R., et al. "Autonomic imbalance as a predictor of metabolic risks, cardiovascular disease, diabetes, and mortality." *The Journal of Clinical Endocrinology & Metabolism*100.6 (2015): 2443-2448.

"RHR and HRV, along with sex, age, and smoking were significant predictors of high blood pressure, hyperglycemia, and a diagnosis of diabetes within 12 years. RHR and HRV also predicted the development of cardiovascular disease and early mortality for most of the sample."

"Two measures of autonomic imbalance predicted multiple poor metabolic outcomes and mortality, making autonomic imbalance a potentially worthy target for intervention studies to reduce risks for cardiovascular disorders, diabetes, and early death."

Mulkey, Sarah B., and Adre J. du Plessis. "Autonomic nervous system development and its impact on neuropsychiatric outcome." *Pediatric research* (2018): 1.

"Modulation of the autonomic vagal impulse controls social responses and that a broad range of neuropsychiatric disorders may be due to impaired vagal balance, with either deficient vagal tone or excessive vagal reactivity. Under additional circumstances of prematurity, growth restriction, and environmental stress in the fetus and newborn, the immature ANS may undergo 'dysmaturation'."

Koopman, F. A., et al. "Autonomic dysfunction precedes development of rheumatoid arthritis: a prospective cohort study." *EBioMedicine* 6 (2016): 231-237.

"Results presented here show that lower parasympathetic activity, as revealed by lower HRV and elevated RHR in AR subjects and RA patients compared to healthy subjects."

"Data presented here are consistent with a pathogenic role of the autonomic nervous system in the development of RA."

"In conclusion, we have found that autonomic imbalance precedes the development of established RA, which could also be relevant for other immune-mediated inflammatory diseases."

Carney, Robert M., Kenneth E. Freedland, and Richard C. Veith. "Depression, the autonomic nervous system, and coronary heart disease." *Psychosomatic medicine* 67 (2005): S29-S33.

> *"Depression is a risk factor for medical morbidity and mortality in patients with coronary heart disease (CHD). Dysregulation of the autonomic nervous system (ANS) may explain why depressed patients are at increased risk. Studies of medically well, depressed psychiatric patients have found elevated levels of plasma catecholamines and other markers of altered ANS function compared with controls. Studies of depressed patients with CHD have also uncovered evidence of ANS dysfunction, including elevated heart rate, low heart rate variability, exaggerated heart rate responses to physical stressors, high variability in ventricular repolarization, and low baroreceptor sensitivity. All of these indicators of ANS dysfunction have been associated with increased risks of mortality and cardiac morbidity in patients with CHD."*

Guarino, Daniela, et al. "The role of the autonomic nervous system in the pathophysiology of obesity." *Frontiers in physiology* 8 (2017): 665.

> *"Indeed, alterations of the ANS might be involved in the pathogenesis of obesity, acting on different pathways."*
>
> *"Given the crucial role of autonomic dysfunction in the pathophysiology of obesity and its cardiovascular complications, vagal nerve modulation and sympathetic inhibition may serve as therapeutic targets in this condition."*

Kishi, Takuya. "Heart failure as an autonomic nervous system dysfunction." *Journal of cardiology* 59.2 (2012): 117-122.

> *"In heart failure, it has been recognized that the sympathetic nervous system (SNS) is activated and the imbalance of the activity of the SNS and vagal activity interaction occurs. The abnormal activation of the SNS leads to further worsening of heart failure."*

Martínez-Martínez, Laura-Aline, et al. "Sympathetic nervous system dysfunction in fibromyalgia, chronic fatigue syndrome, irritable bowel syndrome, and interstitial cystitis: a review of case-control studies." *JCR: Journal of Clinical Rheumatology*20.3 (2014): 146-150.

> *"This review demonstrates that sympathetic nervous system predominance is common in fibromyalgia, chronic fatigue syndrome, irritable bowel syndrome, and interstitial cystitis. This concordance raises the possibility that sympathetic dysfunction could be their common underlying pathogenesis that brings on overlapping clinical features."*

Fisher, J. P., and J. F. R. Paton. "The sympathetic nervous system and blood pressure in humans: implications for hypertension." *Journal of human hypertension* 26.8 (2012): 463.

> *"We propose that the overactivity of the sympathetic nervous system is both a major early prognostic indicator for hypertension and conspirator affecting the heart, vasculature, RAS and immune system. As sympathetic overactivity appears to be present before the hypertensive phenotype, its early antagonism should be considered a potential preventative measure before end organ damage becomes irreversible and hypertension becomes drug resistant."*

Adlan, Ahmed M., et al. "Autonomic function and rheumatoid arthritis—A systematic review." *Seminars in arthritis and rheumatism.* Vol. 44. No. 3. WB Saunders, 2014.

> *"ANS dysfunction is prevalent in ~60% of RA patients. The main pattern of dysfunction is impairment of cardiovascular reflexes and altered HRV, indicative of reduced cardiac parasympathetic (strong evidence) activity and elevated cardiac sympathetic activity (limited evidence)."*

Buchhorn, R., and C. Willaschek. "The Impact of Early Life Stress on Longtime Heart Rate Variability and Neurocognitive Impairment in Infants with Critical Illness–A Comparison of Infants after Preterm Birth and Congenital Heart Disease." *J Heart Stroke. 2018; 3 (2)* 1052.

> *"Follow up studies of children with congenital heart disease, premature birth, small for gestational age syndrome and attention deficit hyperactivity disorder show significantly reduced HRV that indicate autonomic dysfunction."*

Buchhorn, Reiner, et al. "Heart rate variability and methylphenidate in children with ADHD." *ADHD Attention Deficit and Hyperactivity Disorders* 4.2 (2012): 85-91.

> *"Data of this pilot study indicate a decreased vagal tone with significantly diminished HRV and higher heart rates in unmedicated ADHD children."*

Hu, Mandy X., et al. "Basal autonomic activity, stress reactivity, and increases in metabolic syndrome components over time." *Psychoneuroendocrinology* 71 (2016): 119-126.

> "Higher basal sympathetic, lower basal parasympathetic activity, and increased parasympathetic withdrawal during stress are associated with multiple metabolic syndrome (MetS) components, and higher basal sympathetic activity predicts an increase in metabolic abnormalities over time. These findings support a role for ANS dysregulation in the risk for MetS and, consequently, the development of cardiovascular disease."

Hu, Mandy Xian, et al. "Bidirectional prospective associations between cardiac autonomic activity and inflammatory markers." *Psychosomatic medicine* 80.5 (2018): 475-482.

> *"Autonomic imbalance is associated with higher levels of inflammation. Independent data from two studies converge in evidence that higher HR predicts subsequent higher levels of CRP and IL-6. Inflammatory markers may also predict future ANS activity, but evidence for this was less consistent."*

Black, Catherine N., et al. "The association between three major physiological stress systems and oxidative DNA and lipid damage." *Psychoneuroendocrinology* 80 (2017): 56-66.

> *"This large-scale study showed that markers of inflammation, the HPA-axis and ANS are associated with oxidative DNA damage. Oxidative lipid damage is associated with inflammation and the ANS. Increased physiological stress across systems is associated with increasing oxidative damage in a dose-response fashion."*

Wulsin, Lawson R., et al. "The contribution of autonomic imbalance to the development of metabolic syndrome." *Psychosomatic medicine* 78.4 (2016): 474-480.

> *"Obesity, diabetes, and heart disease—the most costly epidemics of our time—share a common but rarely treated mechanism: autonomic imbalance."*

> *"In this community sample, low HRV by both measures (SDNN and root mean square of the standard deviation), high RHR, increased age, cigarette smoking, and being male significantly increased the odds of developing metabolic syndrome within 12 years of baseline."*

Courties, Alice, Jeremie Sellam, and Francis Berenbaum. "Role of the autonomic nervous system in osteoarthritis." *Best Practice & Research Clinical Rheumatology* 31.5 (2017): 661-675.

> *"The vagus nerve has been found to have a strong anti-inflammatory action in other rheumatic diseases through the nicotinic alpha-7 receptor, which is locally expressed by most joint resident cells. Altogether, these data suggest that the ANS is involved in joint homeostasis and OA pathogenesis."*

Woody, Alex, et al. "Stress-induced parasympathetic control and its association with inflammatory reactivity." *Psychosomatic medicine* 79.3 (2017): 306-310.

> *"These findings expand on the current literature by showing that changes in HF-HRV predict and precede changes in circulating inflammatory cytokines in humans and may have implications for treatment of inflammatory diseases."*

Ask, Torvald F., Ricardo G. Lugo, and Stefan Sütterlin. "The Neuro-Immuno-Senescence Integrative Model (NISIM) on the Negative Association Between Parasympathetic Activity and Cellular Senescence." *Frontiers in neuroscience* 12 (2018).

De Couck, Marijke, Boris Mravec, and Yori Gidron. "You may need the vagus nerve to understand pathophysiology and to treat diseases." *Clinical Science* 122.7 (2012): 323-328.

> *"The present article provides evidence for the hypothesis that adequate vagal nerve activity reduces the risk of major diseases, via common basic mechanisms and interim risk factors. These diseases include cardiovascular disease, cancer, Alzheimer's disease and the metabolic syndrome. Three basic mechanisms contribute to such illnesses: local oxidative stress and DNA damage, inflammatory reactions and excessive sympathetic responses, all of which are inhibited by vagal nerve activity. Efferent vagal activity that can be non-invasively measured by HRV (heart rate variability), derived from an ECG, is inversely related to all three basic mechanisms, to various risk factors (e.g. diabetes and dyslipidaemia) and, more broadly, to the diseases as well. Finally, vagal activity is proposed to moderate the effects of risk factors on developing such illnesses. By proposing an integrative neurobiological model of major diseases, identifying people at risk for, and treating patients with, such diseases may be done more efficiently. People with low HRV may be identified and subsequently treated by vagus nerve activation to possibly prevent or treat such illnesses. This proposed disease paradigm may have important preventative and therapeutic implications, whose clinical effects need to be investigated."*

De Couck, Marijke, et al. "Vagal nerve activity predicts overall survival in metastatic pancreatic cancer, mediated by inflammation." *Cancer epidemiology* 40 (2016): 47-51.

> *"Higher initial HRV was significantly correlated with lower risk of death, independent of confounders including age and cancer treatments. This relationship was statistically mediated (accounted for) by CRP levels. Importantly, in patients who lived up to one month from diagnosis only, HRV was unrelated to CRP, while in patients surviving longer, HRV was significantly inversely related to CRP ($r = -0.20$, $p < 0.05$). These results are in line with possible vagal nerve protection in a fatal cancer, and propose that the mechanism may involve neuroimmuno-modulation."*

Gidron, Yori, Marijke De Couck, and J. De Greve. "If you have an active vagus nerve, cancer stage may no longer be important." *Journal of Biological Regulators and Homeostatic Agents* 28.2 (2014): 195-201.

> *"These results show in two diverse cancers that vagal nerve activity, indexed by HRV, needs to be considered when estimating the prognostic effects of basic variables such as tumor stage. Should these results be replicated in other cancers, our observations here may point at a general phenomenon. In addition, the protective findings may also suggest that activating the vagal nerve could improve the prognosis of patients, specifically in those with metastatic cancer."*

Ohira, Hideki, et al. "Vagal nerve activity as a moderator of brain–immune relationships." *Journal of Neuroimmunology*260.1-2 (2013): 28-36.

> *"Participants with low and high baseline HRV underwent a reversal learning task as an acute stressor. Natural killer cells, norepinephrine, and adrenocorticotropic hormone in peripheral blood changed with acute stress in the high HRV group only. Activity in the prefrontal cortex and striatum correlated with the immune and physiological indices in the high HRV group. High vagal tone may reflect more flexible top-down brain regulation of immune and physiological activity."*

Bellinger, Denise, and Dianne Lorton. "Sympathetic Nerve Hyperactivity in the Spleen: Causal for Nonpathogenic-Driven Chronic Immune-Mediated Inflammatory Diseases (IMIDs)?." *International journal of molecular sciences* 19.4 (2018): 1188.

> *"In many Immune-Mediated Inflammatory Diseases (IMIDs), dysautonomia manifests as an imbalance in activity/reactivity of the sympathetic and parasympathetic divisions of the autonomic nervous system (ANS). These major autonomic pathways are essential for allostasis of the immune system, and regulating inflammatory processes and innate and adaptive immunity. Pathology in ANS is a hallmark and causal feature of all IMIDs. Chronic systemic inflammation comorbid with stress pathway dysregulation implicate neural-immune cross-talk in the etiology and pathophysiology of IMIDs."*

> *"Based on our findings in inflammatory arthritis and our understanding of common inflammatory process that are used by the immune system across all IMIDs, novel strategies to restore SNS homeostasis are expected to provide safe, cost-effective approaches to treat IMIDs, lower comorbidities, and increase longevity."*

Provan, Sella A., et al. "Evidence of reduced parasympathetic autonomic regulation in inflammatory joint disease: A meta-analyses study." *Seminars in arthritis and rheumatism*. Vol. 48. No. 1. WB Saunders, 2018.

> *"Patients with inflammatory joint disease have cardiac parasympathetic autonomic dysfunction which is related to inflammation."*

Autonomic Dysfunction in Neurodevelopmental Disorders

Beauchaine, Theodore. "Vagal tone, development, and Gray's motivational theory: Toward an integrated model of autonomic nervous system functioning in psychopathology." *Development and psychopathology* 13.2 (2001): 183-214.

Mulkey, Sarah B., and Adre J. du Plessis. "Autonomic nervous system development and its impact on neuropsychiatric outcome." *Pediatric research* (2018): 1.

> *"The central autonomic nervous system (ANS) is essential for maintaining cardiovascular and respiratory homeostasis in the newborn and has a critical role in supporting higher cortical functions. At birth, the central ANS is maturing and is vulnerable to adverse environmental and physiologic influences. Critical connections are formed early in development between the ANS and limbic system to integrate psychological and body responses. The Polyvagal Theory, developed by Stephen Porges, describes how modulation of the autonomic vagal impulse controls social responses and that a broad range of neuropsychiatric disorders may be due to impaired vagal balance, with either deficient vagal tone or excessive vagal reactivity."*

Sheinkopf, Stephen J., et al. "Developmental Trajectories of Autonomic Functioning in Autism from Birth to Early Childhood." *Biological psychology* (2019).

"This is the first study to describe the longitudinal course of autonomic functioning in infants later diagnosed with autism. Specifically, infants with later autism diagnoses had attenuated growth in RSA, a physiologic process related to social and adaptive functioning. The results suggest that differences in physiological regulation may develop with age in autism, with attenuations in RSA emerging during a period where autism symptoms become prominent and have been shown to be associated with reduced RSA in other samples."

van Hoorn, Alje, et al. "Neuromodulation of autism spectrum disorders using vagal nerve stimulation." *Journal of Clinical Neuroscience* (2019).

Vagus nerve stimulation (VNS) a neuromodulation technique influences ANS. There is some evidence that VNS may improve behaviour in people with ASD.

Bazelmans, Tessel, et al. "Heart rate mean and variability as a biomarker for phenotypic variation in preschoolers with autism spectrum disorder." *Autism Research* (2018).

Althaus, Monika, et al. "Cardiac adaptivity to attention-demanding tasks in children with a pervasive developmental disorder not otherwise specified (PDD-NOS)." *Biological Psychiatry* 46.6 (1999): 799-809.

"Children with PDD-NOS are significantly less flexible in their autonomic adaptation to attention-demanding tasks. The findings are interpreted as reflecting a deficiency in the functional organization of those neural pathways that provide cortical control of the visceral efferents."

Wang, Yao, et al. "Heart rate variability and skin conductance during repetitive TMS course in children with autism." *Applied psychophysiology and biofeedback* 41.1 (2016): 47-60.

"Our post-12 TMS results showed significant increases in cardiac intervals variability measures and decrease of tonic SCL indicative of increased cardiac vagal control and reduced sympathetic arousal. Behavioral evaluations showed decreased irritability, hyperactivity, stereotype behavior and compulsive behavior ratings that correlated with several autonomic variables."

Bujnakova, I., et al. "Autism spectrum disorder is associated with autonomic underarousal." *Physiological research* 65 (2016).

"This study revealed both sympathetic and parasympathetic lower resting activity indicating autonomic underarousal in ASD children."

Axelrod, Felicia B., Gisela G. Chelimsky, and Debra E. Weese-Mayer. "Pediatric autonomic disorders." Pediatrics 118.1 (2006): 309-321.

"The reversal of symptoms through agents that seem to alter central autonomic function further supports direct involvement of autonomic centers in autism."

Mulkey, Sarah B., and Adre J. du Plessis. "Autonomic nervous system development and its impact on neuropsychiatric outcome." *Pediatric research* (2018): 1.

> *"The Polyvagal Theory, developed by Stephen Porges, describes how modulation of the autonomic vagal impulse controls social responses and that a broad range of neuropsychiatric disorders may be due to impaired vagal balance, with either deficient vagal tone or excessive vagal reactivity. Under additional circumstances of prematurity, growth restriction, and environmental stress in the fetus and newborn, the immature ANS may undergo "dysmaturation". Maternal stress and health as well as the intrauterine environment are also quite important and have been implicated in causing ANS changes in the infant and neuropsychiatric diseases in children."*

Premise #3: Interventions that address the autonomic nervous system produce positive physiological and health outcomes.

Multiple modalities and approaches have been shown to positively impact the autonomic nervous system resulting in improvement in health, function and quality of life.

Scientific Basis:

Yuen, Alan WC, and Josemir W. Sander. "Can natural ways to stimulate the vagus nerve improve seizure control?." *Epilepsy & Behavior* 67 (2017): 105-110.

> *"There are numerous natural ways that have been shown to stimulate the VN, improving HRV and hence parasympathetic tone."*

Bonaz, Bruno, Valérie Sinniger, and Sonia Pellissier. "The vagus nerve in the neuro-immune axis: implications in the pathology of the gastrointestinal tract." *Frontiers in immunology* 8 (2017): 1452.

> *"Because of its anti-inflammatory effect, the VN is a therapeutic target in the treatment of chronic inflammatory disorders where TNFα is a key component. In this review, we will focus on the anti-inflammatory role of the VN in inflammatory bowel diseases (IBD). The anti-inflammatory properties of the VN could be targeted pharmacologically, with enteral nutrition, by VN stimulation (VNS), with complementary medicines or by physical exercise. VNS is one of the alternative treatments for drug resistant epilepsy and depression and one might think that VNS could be used as a non-drug therapy to treat inflammatory disorders of the GI tract, such as IBD, irritable bowel syndrome, and postoperative ileus, which are all characterized by a blunted autonomic balance with a decreased vagal tone."*

Koopman, Frieda A., et al. "Vagus nerve stimulation inhibits cytokine production and attenuates disease severity in rheumatoid arthritis." *Proceedings of the National Academy of Sciences* 113.29 (2016): 8284-8289.

> *"Here we show that an implantable vagus nerve-stimulating device in epilepsy patients inhibits peripheral blood production of TNF, IL-1β, and IL-6. Vagus nerve stimulation (up to four times daily) in RA patients significantly inhibited TNF production for up to 84 d. Moreover, RA disease severity, as measured by standardized clinical composite scores, improved significantly. Together, these results establish that vagus nerve stimulation targeting the inflammatory reflex modulates TNF production and reduces inflammation in humans."*

Bonaz, B., V. Sinniger, and Sonia Pellissier. "Vagus nerve stimulation: a new promising therapeutic tool in inflammatory bowel disease." *Journal of internal medicine* 282.1 (2017): 46-63.

Breit, Sigrid, et al. "Vagus nerve as modulator of the brain–gut axis in psychiatric and inflammatory disorders." *Frontiers in psychiatry* 9 (2018): 44.

> *"Treatments that target the vagus nerve increase the vagal tone and inhibit cytokine production. Both are important mechanism of resiliency. The stimulation of vagal afferent fibers in the gut influences monoaminergic brain systems in the brain stem that play crucial roles in major psychiatric conditions, such as mood and anxiety disorders. In line, there is preliminary evidence for gut bacteria to have beneficial effect on mood and anxiety, partly by affecting the activity of the vagus nerve. Since, the vagal tone is correlated with capacity to regulate stress responses and can be influenced by breathing, its increase through meditation and yoga likely contribute to resilience and the mitigation of mood and anxiety symptoms."*

Koopman, F. A., et al. "Balancing the autonomic nervous system to reduce inflammation in rheumatoid arthritis." *Journal of internal medicine* 282.1 (2017): 64-75.

Axelrod, Felicia B., Gisela G. Chelimsky, and Debra E. Weese-Mayer. "Pediatric autonomic disorders." Pediatrics 118.1 (2006): 309-321.

> *"The reversal of symptoms through agents that seem to alter central autonomic function further supports direct involvement of autonomic centers in autism."*

Rome, Peter L. Neurovertebral influence upon the autonomic nervous system: some of the somato-autonomic evidence to date. Chiropractic Journal of Australia 39.1 (2009): 2.

> *"Over 500 papers were assessed and in a few cases only the abstracts were obtainable.… It is noted that the volume of material presented tends to further define the neurological basis of the many clinical observations, and may provide additional explanation for the subjective patient reports of positive responses to manual manipulative intervention. Effectively at this stage, this both underpins and builds upon a long-established empirically based rationale."*

Rome, Peter L. Neurovertebral Influence on Visceral and ANS Function: Some of the Evidence to Date-Part II-Somatovisceral. Chiropractic Journal of Australia 40.1 (2010): 9.

> *"...there appears to be extensive if not overwhelming evidence as to the potential for a manual model for positively influencing the autonomic nervous system and through that, internal pathophysiology and symptoms."*

Eingorn, Alex M., and George J. Muhs. "Rationale for assessing the effects of manipulative therapy on autonomic tone by analysis of heart rate variability." *Journal of manipulative and physiological therapeutics* 22.3 (1999): 161-165.

Kent, C. "Chiropractic and Mental Health: History and Review of Putative Neurobiological Mechanisms." *Jou Neuro Psy An Brain Res: JNPB-103* (2018).

> *"Vertebral subluxations may result in autonomic dysregulation, compromising the adaptive capacity of the organism. By analyzing and correcting vertebral subluxations, a patient is placed on a more optimum physiological path, potentially increasing resilience and adaptability."*

Welch, Arlene, and Ralph Boone. "Sympathetic and parasympathetic responses to specific diversified adjustments to chiropractic vertebral subluxations of the cervical and thoracic spine." *Journal of chiropractic medicine* 7.3 (2008): 86-93.

> *"Diastolic pressure (indicating a sympathetic response) dropped significantly postadjustment among those receiving cervical adjustments, accompanied by a moderate clinical effect (0.50). Pulse pressure increased significantly among those receiving cervical adjustments, accompanied by a large effect size (0.82). Although the decrease in pulse pressure for those receiving thoracic adjustments was not statistically significant, the decrease was accompanied by a moderate effect size (0.66)."*
>
> *"It is preliminarily suggested that cervical adjustments may result in parasympathetic responses, whereas thoracic adjustments result in sympathetic responses. Furthermore, it appears that these responses may demonstrate the relationship of autonomic responses in association to the particular segment(s) adjusted."*

Gosling, Cameron McR, et al. "The short term effect of atlanto-axial high velocity low amplitude manipulation with cavitation on Edge Light Pupil Cycle Time." *International Journal of Osteopathic Medicine* 8.3 (2005): 81-86.

> "Edge Light Pupil Cycle Time (ELPCT), mediated via the ANS, is directly influenced by HVLA manipulation with cavitation to the atlanto-axial joint. The ANS changes observed in this study demonstrated a unilateral response to HVLA manipulation."

Zhang J, Dean D, Nosco D, Strathopulos D, Floros M. Effect of chiropractic care on heart rate variability and pain in a multisite clinical study. J.Manipulative Physiol Ther. 2006;29:267–274.

> *"Data from 96 physicians were divided into single-visit and 4-week groups. After 1 chiropractic adjustment, pain as analyzed by VAS was reduced significantly from 3.7 ± 2.2 to 2.1 ± 2.0 (P < .001). The mean heart rate reduced from 76.7 ± 12.7 to 74.3 ± 12.4 (P < .01), the SD of normal-to-normal QRS increased from a range of 55.8 to 44.6 to a range of 60.6 to 47.2 (P < .001), the high-frequency component increased from 359 ± 968 to 444 ± 1069 (P < .01), the low-frequency component increased from 403 ± 753 to 465 ± 755 (P < .05), and the total power increased from 1063 ± 1886 to 1265 ± 2048 (P < .01). After 4 weeks of chiropractic adjustments, pain measured by the VAS was reduced significantly before and after each visit as analyzed by t tests, but the significant changes were not found using analysis of variance analysis. The reduction of pain from each treatment was not maintained over the 4 weeks of study period. The analysis of variance on the HRV 4-week data found that changes in the SD of normal-to-normal QRS, total power, and low-frequency components reached*

statistically significant levels (P < .05). The heart rate and the high-frequency component did not change significantly (P > .05)."

"In this study, HRV and VAS changed in patients as a result of chiropractic care."

Swensen D. Heart Rate Variability and Spinal Manipulation: A Review of the Literature. JACO Dec 2011.

"The key findings of this investigation indicate that spinal manipulation has an effect upon the autonomic nervous system, and that the analysis of HRV can be used to evaluate that effect."

"There is evidence to support a regional effect of spinal manipulation on sympathovagal balance."

Harris W, Wagnon RJ. The effects of chiropractic adjustments on distal skin temperature. J Manipulative Physiol Ther. 1987;10(2):57-60

"Skin temperature on 196 subjects was measured before and within 10 sec after a spinal adjustment. The difference between the pre- and post-temperatures was determined. The average fingertip temperature did not change when the spine was considered as an entire unit. However, when sympathetic and nonsympathetic regions were analyzed separately, we found significant differences in temperature response. The average temperature rose from 85.84 +/- 6.04 degrees F to 86.26 +/- 6.25 degrees F when C1-C7 and/or L4-L5 were adjusted (p less than 0.001). When the area between T1-L3 was adjusted, however, the average temperature fell from 84.97 +/- 6.11 degrees F to 84.72 +/- 6.19 degrees F (p less than 0.001). These results illustrate that the blood flow through the fingertips can be affected by specific adjustments to the spine, and, further, that the response varies, depending on the location of the adjustment. Thus, adjustments to the spine can, via stimulation of the nervous system, affect the physiology of tissues distant from the spine."

Budgell B, Polus B, The effects of thoracic manipulation on heart rate variability: A controlled crossover trial. J Manipulative Physiol Ther 2006;28(8):603-610.

"In healthy young adults, thoracic spinal manipulation was associated with changes in HRV that were not duplicated by the sham procedure. The ratio of the powers of the low-frequency and high-frequency components increased from 0.9562 +/- 0.9192 to 1.304 +/- 1.118 (P = .0030, Wilcoxon signed rank test). In subjects undergoing sham spinal manipulation, there was no statistically significant change in the low-frequency or the high-frequency component of the power spectrum..."

"High-velocity and low-amplitude manipulation of the thoracic spine appears to be able to influence autonomic output to the heart in ways that are not duplicated by a sham procedure or by other forms of somatic/physical therapies."

Budgell B, Hirano F. Innocuous mechanical stimulation of the neck and alterations in heart-rate variability in healthy young adults. Auton Neurosci. 2001;91(1-2):96-99.

> *"Using a cross-over treatment design, with a one-week washout period and, in contrast to a sham procedure, the authentic manipulation produced significant alterations in both heart rate and measures of heart-rate variability calculated from power spectrum analysis. In particular, there was an increase in the ratio of low-frequency (LF)-to-high-frequency (HF) components of the power spectrum of heart-rate variability, which may reflect a shift in balance between sympathetic and parasympathetic output to the heart."*

Budgell, Brian S. "Reflex effects of subluxation: the autonomic nervous system." *Journal of Manipulative and Physiological Therapeutics* 23.2 (2000): 104-106.

> *"Recent neuroscience research supports a neurophysiologie rationale for the concept that aberrant stimulation of spinal or paraspinal structures may lead to segmentally organized reflex responses of the autonomic nervous system, which in turn may alter visceral function."*

Win, Ni Ni, et al. "Effects of upper and lower cervical spinal manipulative therapy on blood pressure and heart rate variability in volunteers and patients with neck pain: a randomized controlled, cross-over, preliminary study." *Journal of chiropractic medicine* 14.1 (2015): 1-9.

> *"Upper cervical SMT enhances dominance of parasympathetic and lower cervical SMT enhances dominance of sympathetic activity in this young volunteer group. However, dominance of parasympathetic activity was found in patients with neck pain that received both upper and lower cervical SMT."*

Sampath, Kesava Kovanur, et al. "Neuroendocrine response following a thoracic spinal manipulation in healthy men." *journal of orthopaedic & sports physical therapy* 47.9 (2017): 617-627.

> *"Thoracic spinal manipulation (SM) resulted in an immediate decrease in salivary cortisol concentration and reduced T/C ratio 6 hours after intervention. A pattern of immediate sympathetic excitation was also observed in the SM group."*

Holt, Kelly, et al. "Reflex effects of a spinal adjustment on blood pressure." *Chiropractic Journal of Australia* 40.3 (2010): 95.

> *"An adjustment to any segment in the spine resulted in a statistically significant average decrease in systolic blood pressure of 3.9 mmHg. The direction of blood pressure change that was observed was not dependent on the region of the spine adjusted. However, visual analysis suggests cervical and lumbopelvic adjustments had a greater influence on systolic blood pressure than thoracic adjustments. Diastolic blood pressure remained relatively constant. Average changes in blood pressure were unlikely to be clinically significant. However, in individual participants some blood pressure changes were considered to be clinically relevant following an adjustment."*

Welch, Arlene, and Ralph Boone. "Sympathetic and parasympathetic responses to specific diversified adjustments to chiropractic vertebral subluxations of the cervical and thoracic spine." *Journal of chiropractic medicine* 7.3 (2008): 86-93.

> *"Diastolic pressure (indicating a sympathetic response) dropped significantly postadjustment among those receiving cervical adjustments, accompanied by a moderate clinical effect (0.50). Pulse pressure increased significantly among those receiving cervical adjustments, accompanied by a large effect size (0.82). Although the decrease in pulse pressure for those receiving thoracic adjustments was not statistically significant, the decrease was accompanied by a moderate effect size (0.66)."*
>
> *"It is preliminarily suggested that cervical adjustments may result in parasympathetic responses, whereas thoracic adjustments result in sympathetic responses. Furthermore, it appears that these responses may demonstrate the relationship of autonomic responses in association to the particular segment(s) adjusted."*

Premise #4: Improper biomechanics of the spine and associated craniofacial structures as well as postural distortions negatively effect neurophysiology, health, and quality of life.

Structure always affects function. It is an unscientific position to posit that altered spinal biomechanics has only a musculoskeletal effect and does not have neurophysiological consequences.

Malalignment and altered range of motion of the spine, postural distortions, and altered craniofacial symmetries have negative effects on neurophysiology, health and quality of life.

Scientific Basis:

He, Zong-Bao, et al. "Atlantoaxial Misalignment Causes High Blood Pressure in Rats: A Novel Hypertension Model." *BioMed research international* 2017 (2017).

> *"We concluded that we successfully constructed cervical atlantoaxial disorder models in rats that showed hypertension symptom."*

Whedon, James M., and Donald Glassey. "Cerebrospinal fluid stasis and its clinical significance." *Alternative therapies in health and medicine* 15.3 (2009): 54.

> *"There is evidence to suggest that CSF stasis may occur commonly in the absence of pathology or symptomatology, and may have adverse systemic health effects. CSF stasis may be associated with adverse mechanical cord tension, vertebral subluxation syndrome, reduced cranial rhythmic impulse and restricted respiratory function."*

Rosa, Scott, and John W. Baird. "The Craniocervical Junction: Observations regarding the Relationship between Misalignment, Obstruction of Cerebrospinal Fluid Flow, Cerebellar Tonsillar Ectopia, and Image-Guided Correction." *The Craniocervical Syndrome and MRI*. Karger Publishers, 2015. 48-66.

> *"The craniocervical junction is the most complex area of the spinal axis. Due to its complexity it is extremely vulnerable to injuries to the soft tissue stabilizing ligaments and membranous structures. Proper imaging in this area is an essential key to proper diagnosis directing towards the most appropriate and safe treatment options when injury occurs. Misalignments of C_0-C1, C1-C2 brought on by head or neck trauma can manifest in different outcomes. Some of those outcomes can affect or cause neural compromise, and/or some may contribute to cerebrospinal fluid (CSF) flow obstruction as well as arteriovenous compromise. C1 misalignment may also contribute to distention of the cerebellar tonsils (cerebellar tonsillar ectopia), i.e. down through the foramen magnum due to caudal tension by way of dentate ligament pathological stress on the spinal cord leading to obstruction of the normal flow of CSF. Mechanical compression of the jugular vein by the transverse process of C1 has been found to lead to obstruction of outgoing venous blood flow. Such obstruction has been found in chronic cerebral spinal venous insufficiency which has been observed in neurodegenerative brain diseases such as multiple sclerosis. Image-Guided Atlas TreatmentTM (IGATTM) has been shown to be a method of gentle correction of misalignment of C_0-C1, C1-C2, resulting in improved CSF flow as well as venous*

outflow. Image-guided atlas treatment utilizes advanced dynamic upright MRI as the means of evaluating misalignments at the craniocervical junction, and the images obtained are used to calculate the appropriate alignment vectors to correct the misalignment. Post-correction advanced upright MRI images are then used to validate the appropriate realignment of C_0-C1, C1-C2 to establish improvement in proper CSF as well as arteriovenous flow."

Asal, Neşe, and Mehmet Hamdi Şahan. "Is there a relationship between migraine disease and the skull base angles?." *Ortadogu Medical Journal/Ortadogu Tip Dergisi* 10.4 (2018).

"Changes in the skull base angles (modified basal angle and clivo-axial angle) are observed in migraine patients according to magnetic resonance images."

Flanagan, Michael F. "The role of the craniocervical junction in craniospinal hydrodynamics and neurodegenerative conditions." *Neurology research international* 2015 (2015).

"The craniocervical junction (CCJ) is a potential choke point for craniospinal hydrodynamics and may play a causative or contributory role in the pathogenesis and progression of neurodegenerative diseases such as Alzheimer's disease, Parkinson's disease, MS, and ALS, as well as many other neurological conditions including hydrocephalus, idiopathic intracranial hypertension, migraines, seizures, silent-strokes, affective disorders, schizophrenia, and psychosis."

"Malformations and misalignments of the CCJ cause deformation and obstruction of blood and CSF pathways and flow between the cranial vault and spinal canal that can result in faulty craniospinal hydrodynamics and subsequent neurological and neurodegenerative disorders."

Fludder, Christian, and Braden G. Keil. "INSTRUMENT-ASSISTED DELIVERY AND THE PREVALENCE OF REDUCED CERVICAL SPINE RANGE OF MOTION IN INFANTS." *Chiropractic Journal of Australia* 46.2 (2018).

"Vacuum-assisted delivery and Caesarean section delivery were associated with a higher prevalence of reduced cervical spine ROM when compared to vaginal delivery without assistance."

Biernat, Monika, and Monika Bąk-Sosnowska. "The impact of body posture on self-image and psychosocial functioning during adolescence." *PEDIATRIA I MEDYCYNA RODZINNA-PAEDIATRICS AND FAMILY MEDICINE* 14.3 (2018): 282-285.

"We used the available literature to describe the specifics of puberty and factors influencing physical and mental development of adolescents as well as to characterise the most common bone deformity in this group, i.e. idiopathic scoliosis. We also presented the results of scientific research confirming that the discussed spinal deformity and the method of treatment may have a great impact on the quality of life, body perception, mental state and self-esteem of patients. Therefore, we believe that rehabilitation of children with postural defects or deformities, such as scoliosis, should be comprehensive, including the presence of a psychologist in the therapeutic team. At the same time, it seems worth implementing correction and shaping of correct body posture among children with low self-esteem or lack of self-acceptance."

Kado, Deborah M., et al. "Hyperkyphotic posture predicts mortality in older community-dwelling men and women: a prospective study." *Journal of the American Geriatrics Society*52.10 (2004): 1662-1667.

> *"Hyperkyphotic posture, defined as requiring one or more blocks under the occiput to achieve a neutral head position while lying supine, was more common in men than women (44% in men, 22% of women, P<.0001). In age- and sex-adjusted analyses, persons with hyperkyphotic posture had a 1.44 greater rate of mortality (95% confidence interval (CI)=1.12–1.86, P=.005). In multiply adjusted models, the increased rate of death associated with hyperkyphotic posture remained significant (relative hazard=1.40, 95% CI=1.08–1.81, P=.012). In cause-specific mortality analyses, hyperkyphotic posture was specifically associated with an increased rate of death due to atherosclerosis."*
>
> *"Older men and women with hyperkyphotic posture have higher mortality rates."*

Imagama, Shiro, et al. "Back muscle strength and spinal mobility are predictors of quality of life in middle-aged and elderly males." *European Spine Journal* 20.6 (2011): 954-961.

> *"In conclusion, quality of life of the middle-aged and elderly male subjects was related to sagittal balance, lumbar lordosis angle, spinal ROM, and back muscle strength."*

Kado, Deborah M., et al. "Hyperkyphosis predicts mortality independent of vertebral osteoporosis in older women." *Annals of internal medicine* 150.10 (2009): 681-687.

> *"In older women with vertebral fractures, hyperkyphosis predicts an increased risk for death, independent of underlying spinal osteoporosis and the extent and severity of vertebral fractures."*

Katzman, Wendy B., et al. "Age-related hyperkyphosis: its causes, consequences, and management." *journal of orthopaedic & sports physical therapy* 40.6 (2010): 352-360.

> *"Kyphosis is common in older individuals, increases risk for fracture and mortality, and is associated with impaired physical performance, health, and quality of life."*

Ailon, Tamir, et al. "Progressive spinal kyphosis in the aging population." *Neurosurgery* 77.suppl_1 (2015): S164-S172.

> *"Kyphosis is common in older individuals and is associated with adverse health effects and increased mortality. Current evidence suggests a role for nonoperative therapies in reducing kyphosis and delaying its progression."*

Neiva, Patrícia Dayrell, Renata Noce Kirkwood, and Ricardo Godinho. "Orientation and position of head posture, scapula and thoracic spine in mouth-breathing children." *International Journal of Pediatric Otorhinolaryngology* 73.2 (2009): 227-236

> "Mouth breathing children increased scapular superior position in comparison to nasal breathing children due probably to the position of forward head, leading to an alteration in the positioning of the mandible."

Milanesi, Jovana M., et al. "Impact of the mouth breathing occurred during childhood in the adult age: biophotogrammetric postural analysis." *International journal of pediatric otorhinolaryngology* 75.8 (2011): 999-1004.

> *"The results indicate that adults with mouth-breathing childhood have postural alterations, mainly in the head and lumbar column, which keeps for the whole life."*

Okuro, Renata Tiemi, et al. "Exercise capacity, respiratory mechanics and posture in mouth breathers." *Brazilian journal of otorhinolaryngology* 77.5 (2011): 656-662.

> *"Oral breathing children had cervical spine postural changes and decreased respiratory muscle strength compared with nasal breathing."*

Kuroishi, Rita Cristina Sadako, et al. "Deficits in working memory, reading comprehension and arithmetic skills in children with mouth breathing syndrome: analytical cross-sectional study." *Sao Paulo Medical Journal* 133.2 (2015): 78-83.

> *"Children with mouth breathing have low academic achievement and poorer phonological working memory than controls. Teachers and healthcare professionals should be aware of the association of mouth breathing with children's physical and cognitive health."*

Leal, Rossana B., et al. "Impact of breathing patterns on the quality of life of 9-to 10-year-old schoolchildren." *American journal of rhinology & allergy* 30.5 (2016): e147-e152.

> *"Based on the present findings, children with the mouth-breathing pattern experience a greater negative impact on quality of life in comparison with those with the nose-breathing pattern."*

Chaves, Thaís Cristina, et al. "Craniocervical posture and hyoid bone position in children with mild and moderate asthma and mouth breathing." *International journal of pediatric otorhinolaryngology* 74.9 (2010): 1021-1027.

> *"These findings revealed that asthma children presented higher head extension and a higher frequency of changes in hyoid bone position compared to non-asthma children and that greater the asthma severity greater the extension of the upper cervical spine."*

Schertz, Mitchell, Luba Zuk, and Dido Green. "Long-term neurodevelopmental follow-up of children with congenital muscular torticollis." Journal of child neurology 28.10 (2013): 1215-1221.

> *"Of those examined, 22/38 (57.9%) had or were at risk for a developmental disorder (ADHD), developmental coordination disorder, language impairment, autistic spectrum disorder). 23/38 (60.5%) had received developmental treatment during childhood. 30/68 (44.1%) children of the total sample demonstrated a developmental delay/disorder, currently (22/68) or previously (8/68)."*
>
> *"Our findings suggest congenital muscular torticollis to be a significant risk factor for later neurodevelopmental conditions with disorders presenting at different stages of development."*

Stellwagen, Lisa, et al. "Torticollis, facial asymmetry and plagiocephaly in normal newborns." Archives of disease in childhood 93.10 (2008): 827-831.

> *73% of newborns had one or more asymmetry: torticollis (16%), asymmetry of the mandible (13%), facial asymmetry (42%) and asymmetry of the head (61%). Torticollis was associated with maternal report of the fetus being "stuck" in one intrauterine position for more than 6 weeks before delivery. Moderate facial asymmetry was associated with a longer second stage of labour, forceps delivery, a bigger baby and birth trauma. Moderate cranial and mandibular asymmetries were associated with birth trauma. More than one significant asymmetry was found in 10% of newborns.*
>
> *"Asymmetries of the head and neck are very common in normal newborns, and sixteen (16%) of 102 study newborns were found to have torticollis."*

Collett, Brent R., et al. "Development in toddlers with and without deformational plagiocephaly." Archives of pediatrics & adolescent medicine 165.7 (2011): 653-658.

> *"Toddlers with DP scored lower than did unaffected children on all the scales of the Bayley Scales of Infant and Toddler Development, Third Edition. Motor score differences were smaller and cognitive and language score differences were greater than those observed in infancy.*
>
> *"Toddlers with DP continue to exhibit evidence of developmental delays relative to toddlers without DP."*

Canale, S. T., D. W. Griffin, and C. N. Hubbard. "Congenital muscular torticollis. A long-term follow-up." *The Journal of bone and joint surgery. American volume* 64.6 (1982): 810-816.

> *"Some of those with a persistent head tilt had mild, asymptomatic compensatory scoliosis and noticeable cosmetic deformity was present in approximately 31% of the patients."*

Collett, Brent R., et al. "Development in toddlers with and without deformational plagiocephaly." Archives of pediatrics & adolescent medicine 165.7 (2011): 653-658.

> *"Toddlers with DP continue to exhibit evidence of developmental delays relative to toddlers without DP."*

Hutchison, B. L., Alistair W. Stewart, and Edwin A. Mitchell. "Characteristics, head shape measurements and developmental delay in 287 consecutive infants attending a plagiocephaly clinic." *Acta Paediatrica* 98.9 (2009): 1494-1499.

> *"287 consecutive infants presenting to a plagiocephaly outpatient clinic. 58% of cases had a history of limitation of neck function. One or more delays were seen in 36% of infants on the Ages and Stages Questionnaire (ASQ)."*

“Infants with deformational plagiocephaly frequently have neck muscle dysfunction. We postulate that the higher than expected number of developmental delays may be related to the effects of supine sleep position, low or variable tone, lower activity levels, male gender and neck muscle dysfunction.”

Kordestani, Rouzbeh K., et al. "Neurodevelopmental delays in children with deformational plagiocephaly." *Plastic and reconstructive surgery* 117.1 (2006): 207-218.

“This study indicates that before any intervention, infants with deformational plagiocephaly show significant delays in both mental and psychomotor development. Also of particular note is that no child with deformational plagiocephaly showed accelerated development.”

Collett, Brent R., et al. "Development at age 36 months in children with deformational plagiocephaly." Pediatrics (2012): peds-2012.

“224 children with DP and 231 children without diagnosed DP and followed since infancy and assessed with the Bayley Scales of Infant and Toddler Development, Third Edition (BSID-III), Children with DP scored lower on all scales of the BSID-III than children without DP. “

“Differences were largest in cognition, language, and parent-reported adaptive behavior and smallest in motor development.”

Miller, Robert I., and Sterling K. Clarren. "Long-term developmental outcomes in patients with deformational plagiocephaly." *Pediatrics* 105.2 (2000): e26-e26.

“Infants with deformational plagiocephaly comprise a high-risk group for developmental difficulties presenting as subtle problems of cerebral dysfunction during the school-age years.”

Knight, Sarah J., et al. "Early neurodevelopment in infants with deformational plagiocephaly." *Journal of Craniofacial Surgery*24.4 (2013): 1225-1228.

“As a group, infants with DP showed significantly weaker motor skills compared with the normative population.”

Shapiro, I. Jonathan. "Relation between vertical facial asymmetry and postural changes of the spine and ancillary muscles." *Optometry and vision science: official publication of the American Academy of Optometry* 71.8 (1994): 529-538.

“Some patients presenting with head tilt maintain binocular vision by the adaptation of the spinal position. It is suggested that in cases of hyper eye facial asymmetry, where one eye is positioned higher than the other, the head will tilt to equalize the ocular heights in order to maintain binocularity during concentrated visual tasks. This phenomenon is a subdivision of ocular torticollis. The continuous head tilt causes adaptations by the spine and its ancillary muscles.”

Zepa, Inta, et al. "Trunk asymmetry and facial symmetry in young adults." *Acta Odontologica Scandinavica* 61.3 (2003): 149-153.

> *"It was found that frontal head position in relation to the true vertical is stable is constantly maintained close to 90 degrees regardless of moderate trunk asymmetry, indicating that visual perception control is most important in orienting the head in frontal plane. Maintenance of the head position takes place by cervical spine adaptation."*

Lippold, Carsten, et al. "Trunk inclination, pelvic tilt and pelvic rotation in relation to the craniofacial morphology in adults." *The Angle Orthodontist* 77.1 (2007): 29-35.

> *"Statistically significant differences in pelvic torsion were documented with respect to the facial axis and facial depth. Moreover, the differences between patients with various facial asymmetries could be determined for the pelvic torsion."*

Saccucci, Matteo, et al. "Scoliosis and dental occlusion: a review of the literature." *Scoliosis* 6.1 (2011): 15.

> *"Beyond possibly causing TMJ diseases, dental malocclusions could, by the same mechanism, be linked to a functional asymmetry of trunk muscles. We suggest that one pathway is through the atlas. The atlas is linked to occipital condyles and thus affect the rest of the spine alignment, leading to further profound compensatory changes, that may become pathological."*

Gutmann, G. "Blocked Atlantal Nerve Syndrome in babies and infants." *Manuelle Medizin* 25 (1987): 5-10.

> *"With developmental disturbances of every kind the alanto-occipital joints should be evaluated and in each case treated manually in a qualified manner."*

Frymann, Viola. "Relation of disturbances of craniosacral mechanisms to symptomatology of the newborn: study of 1,250 infants." *The Journal of the American Osteopathic Association* 65.10 (1966): 1059-1075.

Premise #5: Adjusting subluxated vertebrae is exceedingly safe and has positive neurophysiological, health and quality of life outcomes.

Chiropractic adjustments are exceedingly safe and have been shown to be associated with positive neurophysiological changes and improvements in health and quality of life.

Scientific Basis:

Thiel, Haymo W., et al. "Safety of chiropractic manipulation of the cervical spine: a prospective national survey." *Spine* 32.21 (2007): 2375-2378.

> *"Data were obtained from 28,807 treatment consultations and 50,276 cervical spinemanipulations. There were no reports of serious adverse events. This translates to an estimated risk of a serious adverse event of, at worse ≈1 per 10,000 treatment consultations immediately after cervical spine manipulation, ≈2 per 10,000 treatment consultations up to 7 days after treatment and ≈6 per 100,000 cervical spine manipulations. Minor side effects with a possible neurologic involvement were more common. The highest risk immediately after treatment was fainting/dizziness/light-headedness in, at worse ≈16 per 1000 treatment consultations. Up to 7 days after treatment, these risks were headache in, at worse ≈4 per 100, numbness/tingling in upper limbs in, at worse ≈15 per 1000 and fainting/dizziness/light-headedness in, at worse ≈13 per 1000 treatment consultations."*
>
> *"Although minor side effects following cervical spine manipulation were relatively common, the risk of a serious adverse event, immediately or up to 7 days after treatment, was low to very low."*

Todd, Angela J., et al. "Adverse events due to chiropractic and other manual therapies for infants and children: a review of the literature." *Journal of manipulative and physiological therapeutics* 38.9 (2015): 699-712.

> *"Published cases of serious adverse events in infants and children receiving chiropractic, osteopathic, physiotherapy, or manual medical therapy are rare."*

Alcantara, Joel, Jeanne Ohm, and Derek Kunz. "The safety and effectiveness of pediatric chiropractic: a survey of chiropractors and parents in a practice-based research network." *Explore: The Journal of Science and Healing* 5.5 (2009): 290-295.

> *"The indicated primary reason for chiropractic care of children was "wellness care." With respect to condition-based presentations, musculoskeletal conditions were the most common in addition to nonmusculoskeletal conditions of childhood. The most common technique utilized were Diversified Technique, Gonstead Technique, Thompson Technique and Activator Methods. Treatment-associated complications were not indicated by the chiropractic and parent responders. Chiropractor responders indicated 3 per 5438 treatment-associated aggravations from the treatment of 577 children. The parents indicated 2 treatment associated aggravations from 1735 SMT clinical encounters involving 239 patients. Both sets of responders indicated a high rate of improvement with respect to the patients' presenting complaints, in addition to salutary effects unrelated to their clinical presentations."*

Doyle, Matthew F. "Is chiropractic paediatric care safe? A best evidence topic." *Clinical Chiropractic* 14.3 (2011): 97-105.

> *"The reviewed published chiropractic literature suggests a rate of 0.53% to 1% mild adverse events (AE) associated with chiropractic paediatric manipulative therapy (PMT)."*

Fedorchuk, C., et al. "Increased telomere length and improvements in dysautonomia, quality of life, and neck and back pain following correction of sagittal cervical alignment using Chiropractic BioPhysics® technique: a case study." *J Mol Genet Med* 11.269 (2017): 1747-0862.

> *"Our case suggests, for the first time, that cervical spinal alignment and posture may be directly related to TL (health longevity) and that correction thereof may have a directly related effect on health longevity as represented by TL. This case adds more evidence to claims that cervical spinal alignment may also improve autonomic function (HRV and bladder function), QoL, and neck and back pain."*

Welch, Arlene, and Ralph Boone. "Sympathetic and parasympathetic responses to specific diversified adjustments to chiropractic vertebral subluxations of the cervical and thoracic spine." *Journal of chiropractic medicine* 7.3 (2008): 86-93.

> *"Diastolic pressure (indicating a sympathetic response) dropped significantly postadjustment among those receiving cervical adjustments, accompanied by a moderate clinical effect (0.50). Pulse pressure increased significantly among those receiving cervical adjustments, accompanied by a large effect size (0.82). Although the decrease in pulse pressure for those receiving thoracic adjustments was not statistically significant, the decrease was accompanied by a moderate effect size (0.66)."*
>
> *"It is preliminarily suggested that cervical adjustments may result in parasympathetic responses, whereas thoracic adjustments result in sympathetic responses. Furthermore, it appears that these responses may demonstrate the relationship of autonomic responses in association to the particular segment(s) adjusted."*

Kelly, David D., Bernadette A. Murphy, and David P. Backhouse. "Use of a mental rotation reaction-time paradigm to measure the effects of upper cervical adjustments on cortical processing: a pilot study." *Journal of manipulative and physiological therapeutics* 23.4 (2000): 246-251.

> *"The results of this study have demonstrated a significant improvement in a complex reaction-time task after an upper cervical adjustment. These results provide evidence that upper cervical adjustment may affect cortical processing."*

Gosling, Cameron McR, et al. "The short term effect of atlanto-axial high velocity low amplitude manipulation with cavitation on Edge Light Pupil Cycle Time." *International Journal of Osteopathic Medicine* 8.3 (2005): 81-86.

"Edge Light Pupil Cycle Time (ELPCT), mediated via the ANS, is directly influenced by HVLA manipulation with cavitation to the atlanto-axial joint. The ANS changes observed in this study demonstrated a unilateral response to HVLA manipulation."

Zhang J, Dean D, Nosco D, Strathopulos D, Floros M. Effect of chiropractic care on heart rate variability and pain in a multisite clinical study. J.Manipulative Physiol Ther. 2006;29:267–274.

"Data from 96 physicians were divided into single-visit and 4-week groups. After 1 chiropractic adjustment, pain as analyzed by VAS was reduced significantly from 3.7 ± 2.2 to 2.1 ± 2.0 (P < .001). The mean heart rate reduced from 76.7 ± 12.7 to 74.3 ± 12.4 (P < .01), the SD of normal-to-normal QRS increased from a range of 55.8 to 44.6 to a range of 60.6 to 47.2 (P < .001), the high-frequency component increased from 359 ± 968 to 444 ± 1069 (P < .01), the low-frequency component increased from 403 ± 753 to 465 ± 755 (P < .05), and the total power increased from 1063 ± 1886 to 1265 ± 2048 (P < .01). After 4 weeks of chiropractic adjustments, pain measured by the VAS was reduced significantly before and after each visit as analyzed by t tests, but the significant changes were not found using analysis of variance analysis. The reduction of pain from each treatment was not maintained over the 4 weeks of study period. The analysis of variance on the HRV 4-week data found that changes in the SD of normal-to-normal QRS, total power, and low-frequency components reached statistically significant levels (P < .05). The heart rate and the high-frequency component did not change significantly (P > .05)."

"In this study, HRV and VAS changed in patients as a result of chiropractic care."

Swensen D. Heart Rate Variability and Spinal Manipulation: A Review of the Literature. JACO Dec 2011.

"The key findings of this investigation indicate that spinal manipulation has an effect upon the autonomic nervous system, and that the analysis of HRV can be used to evaluate that effect."

"There is evidence to support a regional effect of spinal manipulation on sympathovagal balance."

Harris W, Wagnon RJ. The effects of chiropractic adjustments on distal skin temperature. J Manipulative Physiol Ther. 1987;10(2):57-60

"Skin temperature on 196 subjects was measured before and within 10 sec after a spinal adjustment. The difference between the pre- and post-temperatures was determined. The average fingertip temperature did not change when the spine was considered as an entire unit. However, when sympathetic and nonsympathetic regions were analyzed separately, we found significant differences in temperature response. The average temperature rose from 85.84 +/- 6.04 degrees F to 86.26 +/- 6.25 degrees F when C1-C7 and/or L4-L5 were adjusted (p less than 0.001). When the area between T1-L3 was adjusted, however, the average temperature fell from 84.97 +/- 6.11 degrees F to 84.72 +/- 6.19 degrees F (p less than 0.001). These results illustrate that the blood flow through the fingertips can be affected by specific adjustments to the spine, and, further, that the response varies, depending on the location of the adjustment. Thus, adjustments to the spine can, via stimulation of the nervous system, affect the physiology of tissues distant from the spine."

Budgell B, Polus B, The effects of thoracic manipulation on heart rate variability: A controlled crossover trial. J Manipulative Physiol Ther 2006;28(8):603-610.

> *"In healthy young adults, thoracic spinal manipulation was associated with changes in HRV that were not duplicated by the sham procedure. The ratio of the powers of the low-frequency and high-frequency components increased from 0.9562 +/- 0.9192 to 1.304 +/- 1.118 (P = .0030, Wilcoxon signed rank test). In subjects undergoing sham spinal manipulation, there was no statistically significant change in the low-frequency or the high-frequency component of the power spectrum..."*

> *"High-velocity and low-amplitude manipulation of the thoracic spine appears to be able to influence autonomic output to the heart in ways that are not duplicated by a sham procedure or by other forms of somatic/physical therapies."*

Budgell B, Hirano F. Innocuous mechanical stimulation of the neck and alterations in heart-rate variability in healthy young adults. Auton Neurosci. 2001;91(1-2):96-99.

> *"Using a cross-over treatment design, with a one-week washout period and, in contrast to a sham procedure, the authentic manipulation produced significant alterations in both heart rate and measures of heart-rate variability calculated from power spectrum analysis. In particular, there was an increase in the ratio of low-frequency (LF)-to-high-frequency (HF) components of the power spectrum of heart-rate variability, which may reflect a shift in balance between sympathetic and parasympathetic output to the heart."*

Budgell, Brian S. "Reflex effects of subluxation: the autonomic nervous system." *Journal of Manipulative and Physiological Therapeutics* 23.2 (2000): 104-106.

> *"Recent neuroscience research supports a neurophysiologie rationale for the concept that aberrant stimulation of spinal or paraspinal structures may lead to segmentally organized reflex responses of the autonomic nervous system, which in turn may alter visceral function."*

Win, Ni Ni, et al. "Effects of upper and lower cervical spinal manipulative therapy on blood pressure and heart rate variability in volunteers and patients with neck pain: a randomized controlled, cross-over, preliminary study." *Journal of chiropractic medicine* 14.1 (2015): 1-9.

> *"Upper cervical SMT enhances dominance of parasympathetic and lower cervical SMT enhances dominance of sympathetic activity in this young volunteer group. However, dominance of parasympathetic activity was found in patients with neck pain that received both upper and lower cervical SMT."*

Sampath, Kesava Kovanur, et al. "Neuroendocrine response following a thoracic spinal manipulation in healthy men." *journal of orthopaedic & sports physical therapy* 47.9 (2017): 617-627.

> *"Thoracic spinal manipulation (SM) resulted in an immediate decrease in salivary cortisol concentration and reduced T/C ratio 6 hours after intervention. A pattern of immediate sympathetic excitation was also observed in the SM group."*

Holt, Kelly, et al. "Reflex effects of a spinal adjustment on blood pressure." *Chiropractic Journal of Australia* 40.3 (2010): 95.

> *"An adjustment to any segment in the spine resulted in a statistically significant average decrease in systolic blood pressure of 3.9 mmHg. The direction of blood pressure change that was observed was not dependent on the region of the spine adjusted. However, visual analysis suggests cervical and lumbopelvic adjustments had a greater influence on systolic blood pressure than thoracic adjustments. Diastolic blood pressure remained relatively constant. Average changes in blood pressure were unlikely to be clinically significant. However, in individual participants some blood pressure changes were considered to be clinically relevant following an adjustment."*

Fedorchuk, C., et al. "Increased telomere length and improvements in dysautonomia, quality of life, and neck and back pain following correction of sagittal cervical alignment using Chiropractic BioPhysics® technique: a case study." *J Mol Genet Med* 11.269 (2017): 1747-0862.

> *"Our case suggests, for the first time, that cervical spinal alignment and posture may be directly related to TL (health longevity) and that correction thereof may have a directly related effect on health longevity as represented by TL. This case adds more evidence to claims that cervical spinal alignment may also improve autonomic function (HRV and bladder function), QoL, and neck and back pain."*

Kovanur-Sampath, Kesava, et al. "Changes in biochemical markers following spinal manipulation-a systematic review and meta-analysis." *Musculoskeletal Science and Practice* 29 (2017): 120-131.

> *"The current review found that spinal manipulation can increase substance-p, neurotensin, oxytocin and interleukin levels and may influence cortisol levels post-intervention."*

García-Pérez-Juana, Daniel, et al. "Changes in Cervicocephalic Kinesthetic Sensibility, Widespread Pressure Pain Sensitivity, and Neck Pain After Cervical Thrust Manipulation in Patients With Chronic Mechanical Neck Pain: A Randomized Clinical Trial." *Journal of manipulative and physiological therapeutics* 41.7 (2018): 551-560.

> *"Our results suggest that cervical spine thrust manipulation improves JPSE, PPT and NDI in participants with chronic mechanical neck pain."*

Ogura, T., Tashiro, M., Masud, M., Watanuki, S., Shibuya, K., Yamaguchi, K., ... & Yanai, K. (2011). Cerebral metabolic changes in men after chiropractic spinal manipulation for neck pain. *Alternative Therapies in Health & Medicine*, *17*(6).

> *"Brain PET scanning was performed twice on each participant, at resting and after CSM. Questionnaires were used for subjective evaluations. A visual analogue scale (VAS) was rated by participants before and after chiropractic treatment, and muscle tone and salivary amylase were measured. RESULTS: Increased glucose metabolism was observed in the inferior prefrontal cortex, anterior cingulated cortex, and middle temporal gyrus, and decreased glucose metabolism was found in the cerebellar vermis and visual association cortex, in the treatment condition (P < .001). Comparisons of questionnaires indicated a lower stress level and better quality of life in the treatment condition. A significantly lower VAS was noted after CSM. Cervical muscle tone and salivary amylase were decreased after CSM. Conclusion The results of this study suggest that CSM affects regional cerebral glucose metabolism related to sympathetic relaxation and pain reduction."*

Lelic, Dina, et al. Manipulation of Dysfunctional Spinal Joints Affects Sensorimotor Integration in the Prefrontal Cortex: A Brain Source Localization Study. Neural plasticity 2016 (2016).

> *"Nineteen SCP volunteers attended two experimental sessions, SM and control in random order. SEPs from 62-channel EEG cap were recorded following median nerve stimulation (1000 stimuli at 2.3 Hz) before and after either intervention. Peak-to-peak amplitude and latency analysis was completed for different SEPs peak. Dipolar models of underlying brain sources were built by using the brain electrical source analysis. Two-way repeated measures ANOVA was used to assessed differences in N30 amplitudes, dipole locations, and dipole strengths. Results. SM decreased the N30 amplitude by % (), while no differences were seen following the control intervention (). Brain source modeling revealed a 4-source model but only the prefrontal source showed reduced activity by % () following SM.Conclusion. A single session of spinal manipulation of dysfunctional segments in subclinical pain patients alters somatosensory processing at the cortical level, particularly within the prefrontal cortex."*

Haavik Taylor H, Holt K, Murphy B. Exploring the Neuromodulatory Effects of the Vertebral Subluxation and Chiropractic Care, Chiropractic Journal of Australia 2010; 40: 37-44.

> *"Many of the studies discussed in this paper show that chiropractic adjustments result in changes to sensorimotor integration within the central nervous system."*

Haavik Taylor H, Murphy B. Cervical spine manipulation alters sensorimotor integration: A somatosensory evoked potential study, Clinical Neurophysiology, February 2007

> *"Twelve subjects with a history of reoccurring neck stiffness and/or neck pain, but no acute symptoms at the time of the study were invited to participate in the study. An additional twelve subjects participated in a passive head movement control experiment. Spinal (N11, N13) brainstem (P14) and cortical (N20, N30) SEPs to median nerve stimulation were recorded before and for 30min after a single session of cervical spine manipulation, or passive head movement. RESULTS: There was a significant decrease in the amplitude of parietal N20 and frontal N30 SEP components following the single session of cervical spine manipulation compared to pre-manipulation baseline values. These changes lasted on average 20min following the manipulation intervention. No changes were observed in the passive head*

movement control condition. CONCLUSIONS: Spinal manipulation of dysfunctional cervical joints can lead to transient cortical plastic changes, as demonstrated by attenuation of cortical somatosensory evoked responses."

Haavik Taylor H, Murphy, B. The role of spinal manipulation in addressing disordered sensorimotor integration and altered motor control. Journal of Electromyography and Kinesiology, 2012 Oct;22(5):768-76.

Haavik Taylor H., & Murphy, B. (2011). Subclinical neck pain and the effects of cervical manipulation on elbow joint position sense. Journal of manipulative and physiological therapeutics, 34(2), 88-97.

"At baseline, the control group was significantly better at reproducing the elbow target angle. The SCNP group's absolute error significantly improved after the cervical adjustments when the participants' heads were in the neutral and left-rotation positions. They displayed a significant overall decrease in variable error after the cervical adjustments. The control group participants' JPS accuracy was worse after the control intervention, with a significant overall effect in absolute and variable errors. No other significant effects were detected. CONCLUSION: These results suggest that asymptomatic people with a history of SCNP have reduced elbow JPS accuracy compared to those with no history of any neck complaints. Furthermore, the results suggest that adjusting dysfunctional cervical segments in people with SCNP can improve their upper limb JPS accuracy."

Haavik Taylor, H., & Murphy, B. (2007). Transient modulation of intracortical inhibition following spinal manipulation. Chiropractic Journal of Australia, 37(3), 106.

"Spinal manipulation of dysfunctional cervical joints can lead to transient central neural plastic changes, as demonstrated by shortening of the transcranial magnetic stimulation-induced cortical silent periods. This study suggests that cervical spine manipulation may alter sensorimotor integration."

Haavik Taylor H, Murphy B. (2010). The effects of spinal manipulation on central integration of dual somatosensory input observed after motor training: a crossover study. Journal of manipulative and physiological therapeutics, 33(4), 261-272.

"There was a significant increase in the MU/M+U ratio for both cortical (ie, N20-P25 and P22-N30) SEP components after the 20-minute repetitive contraction task. This did not occur when the motor training task was preceded with spinal manipulation. Instead, there was a significant decrease in the MU/M+U ratio for the cortical P22-N30 SEP component. The ratio changes appear to be due to changes in the ability to suppress the dual input as concurrent changes in the MU amplitudes were observed. DISCUSSION: This study suggests that cervical spine manipulation not only alters cortical integration of dual somatosensory input but also alters the way the central nervous system responds to subsequent motor training tasks."

Haavik Taylor H, Murphy B. (2010). Altered central integration of dual somatosensory input after cervical spine manipulation. Journal of manipulative and physiological therapeutics, 33(3), 178-188.

> *"The observations in the present study suggest that spinal manipulation of dysfunctional cervical joints may improve suppression of SEPs evoked by dual upper limb nerve stimulation at the level of the motor cortex, premotor areas, and/or subcortical areas such as basal ganglia and/or thalamus, lasting at least 20 minutes postmanipulation."*

Haavik Taylor H, Murphy, B. (2008). Altered sensorimotor integration with cervical spine manipulation. Journal of manipulative and physiological therapeutics, 31(2), 115-126.

> *"Spinal manipulation of dysfunctional cervical joints may alter specific central corticomotor facilitatory and inhibitory neural processing and cortical motor control of 2 upper limb muscles in a muscle-specific manner. This suggests that spinal manipulation may alter sensorimotor integration."*

Dimmick KR, Young MF, Newell D. Chiropractic manipulation affects the difference between arterial systolic blood pressures on the left and right normotensive subjects. J Manipulative Physiol Ther 2006;29(1):46-50

> *"Chiropractic treatment appears to have an effect on the difference in systolic blood pressure between the arms, which is not shown in the control group or the diastolic treatment group values."*

Carrick FR. Changes in brain function after manipulation of the cervical spine. J Manipulative Physiol Ther 1997;20(8):529-545.

> *"Accurate reproducible maps of cortical responses can be used to measure the neurological consequences of spinal joint manipulation. Cervical manipulation activates specific neurological pathways. Manipulation of the cervical spine may be associated with an increase or a decrease in brain function depending upon the side of the manipulation and the cortical hemisphericity of a patient."*

Masud, Md Mehedi, et al. "Glucose Metabolic Changes in the Brain and Muscles of Patients with Nonspecific Neck Pain Treated by Spinal Manipulation Therapy: A..." (2017).

> *"Changes in brain activity after SMT included activation of the dorsal anterior cingulate cortex, cerebellar vermis, and somatosensory association cortex and deactivation of the prefrontal cortex and temporal sites. Glucose uptake in skeletal muscles showed a trend toward decreased metabolism after SMT, although the difference was not significant. Other measurements indicated relaxation of cervical muscle tension, decrease in salivary amylase level (suppression of sympathetic nerve activity), and pain relief after SMT."*

> *"In summary, we observed metabolic changes in the brain and skeletal muscles, as well as reductions in subjective pain, muscle tension, and salivary amylase, after SMT intervention. These results may be associated with reduced sympathetic nerve activity, suggesting that SMT induces a kind of relaxation similar to that achieved by biofeedback. The brain response to SMT may reflect the psychophysiological relaxation that accompanies reduced sympathetic nerve activity."*

Niazi, Imran Khan, et al. "Changes in H-reflex and V-waves following spinal manipulation." *Experimental brain research* 233.4 (2015): 1165-1173.

> *"The H-reflex pathway is involved in the neural plastic changes that occur following spinal manipulation. The improvements in MVC following spinal manipulation are likely attributed to increased descending drive and/or modulation in afferents. Spinal manipulation appears to prevent fatigue developed during maximal contractions. Spinal manipulation appears to alter the net excitability of the low-threshold motor units, increase cortical drive, and prevent fatigue."*

Rosa, Scott, and John W. Baird. "The Craniocervical Junction: Observations regarding the Relationship between Misalignment, Obstruction of Cerebrospinal Fluid Flow, Cerebellar Tonsillar Ectopia, and Image-Guided Correction." *The Craniocervical Syndrome and MRI*. Karger Publishers, 2015. 48-66.

> *"The craniocervical junction is the most complex area of the spinal axis. Due to its complexity it is extremely vulnerable to injuries to the soft tissue stabilizing ligaments and membranous structures. Proper imaging in this area is an essential key to proper diagnosis directing towards the most appropriate and safe treatment options when injury occurs. Misalignments of C₀-C1, C1-C2 brought on by head or neck trauma can manifest in different outcomes. Some of those outcomes can affect or cause neural compromise, and/or some may contribute to cerebrospinal fluid (CSF) flow obstruction as well as arteriovenous compromise. C1 misalignment may also contribute to distention of the cerebellar tonsils (cerebellar tonsillar ectopia), i.e. down through the foramen magnum due to caudal tension by way of dentate ligament pathological stress on the spinal cord leading to obstruction of the normal flow of CSF. Mechanical compression of the jugular vein by the transverse process of C1 has been found to lead to obstruction of outgoing venous blood flow. Such obstruction has been found in chronic cerebral spinal venous insufficiency which has been observed in neurodegenerative brain diseases such as multiple sclerosis. Image-Guided Atlas TreatmentTM (IGATTM) has been shown to be a method of gentle correction of misalignment of C₀-C1, C1-C2, resulting in improved CSF flow as well as venous outflow. Image-guided atlas treatment utilizes advanced dynamic upright MRI as the means of evaluating misalignments at the craniocervical junction, and the images obtained are used to calculate the appropriate alignment vectors to correct the misalignment. Post-correction advanced upright MRI images are then used to validate the appropriate realignment of C₀-C1, C1-C2 to establish improvement in proper CSF as well as arteriovenous flow."*

Bakris, G., et al. "Atlas vertebra realignment and achievement of arterial pressure goal in hypertensive patients: a pilot study." *Journal of human hypertension* 21.5 (2007): 347.

> *"We conclude that restoration of Atlas alignment is associated with marked and sustained reductions in BP similar to the use of two-drug combination therapy."*

Douglas, Nicola Ann, Maria Browning, and Joyce Miller. "Chiropractic care for the cervical spine as a treatment for plagiocephaly: a prospective cohort study." *JOURNAL OF CLINICAL CHIROPRACTIC PEDIATRICS*: 1273.

> *The infants' plagiocephaly measurement significantly reduced over the course of 6 weeks of chiropractic care. Out of the sample of 64 participants, 20 showed a complete resolution of head deformation, a value of 0.4cm or less difference between left and right side which is widely recorded as a normal,*

almost imperceptible difference. The remaining infants showed a reduction in the plagiocephaly measurement with a mean reduction of 1.13cm

Gordon, Brent D. "A RETROSPECTIVE STUDY OF THE MANAGEMENT OF DEFORMATIONAL PLAGIOCEPHALY WITH CHIROPRACTIC CARE." *Chiropractic Journal of Australia* 45.2 (2017).

Diagonal skull measurements were analysed from 23 infants determined to have mild (3-7%), moderate (7-12%) or severe (>12%) DP using the cranial vault asymmetry index (CVAI).

The 17 children who utilized pillows in conjunction with chiropractic treatment had their mean CVAI decrease from 8.81% (SD 2.41%) to 5.17% (SD 2.90%) (D CVAI 3.64%), whereas the six children who had chiropractic treatment alone had their mean CVAI decrease from 8.67% (SD 3.50%) to 2.99% (SD 2.12%) (D CVAI 5.68%), an overall improvement of 65.5%.

Cuthbert, Scott C., and Michel Barras. "Developmental delay syndromes: psychometric testing before and after chiropractic treatment of 157 children." *Journal of manipulative and physiological therapeutics* 32.8 (2009): 660-669.

"The outcome measures were a series of 8 standardized psychometric tests given to the children by a certified speech therapist pre- and posttreatment, which evaluate 20 separate areas of cognitive function, including patient- or parent-reported improvements in school performance, social interaction, and sporting activities. Individual and group data showed that at the end of treatment, the 157 children showed improvements in the 8 psychometric tests and 20 areas of cognitive function compared with their values before treatment. Their ability to concentrate, maintain focus and attention, and control impulsivity and their performance at home and school improved."

Hannon, S. "Objective physiologic changes and associated health benefits of chiropractic adjustments in asymptomatic subjects: a review of the literature." *Journal of Vertebral Subluxation Research* (2004): 1-9.

"Considering that these initial findings document objectively measured physiologic changes and their associated health benefits in nearly every major system of the human body, it is plausible that chiropractic care may benefit every function of the body."

"Furthermore, these data are congruent with numerous subjective studies that suggest chiropractic care is associated with accruing, longterm, overall health benefits."

Selano, J. L., et al. "The effects of specific upper cervical adjustments on the CD4 counts of HIV positive patients." *Chiropr Res J* 3.1 (1994): 32-39.

"The effect of specific upper cervical adjustments on the immune system CD4 cell counts of HIV positive individuals was measured by CD4/mm3 in the blood. These tests were performed by the patients independent medical center where they were under medical supervision for the regular group were dramatically increased over the counts of the control group. A 48% increase in CD4 cells was demonstrated over the six month duration of the study for the adjusted group."

Coulter, Ian D., et al. "Chiropractic patients in a comprehensive home-based geriatric assessment, follow-up and health promotion program." (1996).

> *"Within a total sample size of 414, a subpopulation of 23 (5.65%) reported receiving chiropractic care. This figure is similar to published reports of distribution of chiropractic patients in the general population. Chiropractic users were less likely to have been hospitalized, less likely to have used a nursing home, more likely to report a better health status, more likely to exercise vigorously, and more likely to be mobile in the community. In addition, they were less likely to use prescription drugs."*
>
> *"These observations suggest the possible long-term health benefits of chiropractic utilization regardless of the presence or absence of symptoms"*

Ari Cohn, D. C. "Chiropractic and the neuroimmune connection." Journal of Vertebral Subluxation Research ~ September 30, 2008.

> *"For many years chiropractors have claimed that spinal adjustments can help improve the overall health of an individual. There is a growing body of scientific research to support this contention."*

Campbell, Clayton J., et al. "Surrogate indication of DNA repair in serum after long term chiropractic intervention-a retrospective study." *Journal of Vertebral Subluxation Research* (2005): 1-5.

> *"Asymptomatic or primary wellness subjects under chiropractic care demonstrated higher mean serum thiol levels than patients with active disease and produced some values that were higher than normal wellness values"*

Brennan, P. C., et al. "Enhanced neutrophil respiratory burst as a biological marker for manipulation forces: duration of the effect and association with substance P and tumor necrosis factor." *Journal of manipulative and physiological therapeutics*15.2 (1992): 83-89.

> "There was a significant difference in the respiratory burst of polymorphonuclear neutrophils in response to a particulate challenge, depending on the time of blood sample collection. The response of polymorphonuclear neutrophils isolated from blood collected 15 min after manipulation was significantly higher than the response of cells isolated from blood collected 15 min before and 30 and 45 min after manipulation. Mononuclear cells were also primed for enhanced endotoxin-stimulated tumor necrosis factor production by spinal manipulation. Both of these priming effects were accompanied by a slight, but significant elevation in plasma substance P."

Blanks, R. H., Tonya L. Schuster, and Marnie Dobson. "A retrospective assessment of network care using a survey of self-rated health, wellness, and quality of life." *Journal of Vertebral Subluxation Research* 1.4 (1997): 1.

> *"The evidence of improved health in the four domains (physical state, mental/emotional state, stress evaluation, life enjoyment), overall quality of life from a standardized index, and the "wellness coefficient," suggests that Network Care is associated with significant benefits.These benefits are evident from as early as 1-3 months under care, and appear to show continuing clinical improvements in the duration of care intervals studied, with no indication of a maximum clinical benefit."*

As mentioned earlier, this document is only a small sampling of the available literature. There is much more that can be easily found by anyone interested in learning more. Simply visit the Index to Chiropractic Literature and search for relevant topics.

Below is a small sampling of pediatric case studies.

McCormick, Janette. "Improvement in motor developmental delay in a 15-month old male following chiropractic care to correct vertebral subluxation: A case report." *JOURNAL OF CLINICAL CHIROPRACTIC PEDIATRICS*: 1405.

Manis, A., and M. Rubinstein. "Resolution of motor tics, ADHD and discontinuation of medications in a 10-year-old male twin following upper cervical chiropractic care: a case study." *Journal of Upper Cervical Chiropractic Research* (2014): 68-71.

Wolfertz, M. T., and V. L. Dahlberg. "Upper cervical chiropractic care for a sixteen-year-old male with bipolar disorder, attention deficit hyperactivity disorder and vertebral subluxation." *Journal of Upper Cervical Chiropractic Research*2 (2012): 55-62.

Eric Zielinski, Kahlid Mankal, D. C. "An Epidemiological Approach to the Effects of Subluxation-Based Chiropractic Care on the Management of ADHD, Depression and Learning Disabilities in an 8-Year Old: A Case Study."

Hodgson N and Vaden C. Improvement in signs and symptoms of adhd and functional outcomes in four children receiving torque release chiropractic: A case series. Ann Vert Sublux Res. 2014;2:55-79.

Alcantara, Joel, and James Davis. "The chiropractic care of children with attention-deficit/hyperactivity disorder: a retrospective case series." *Explore* 6.3 (2010): 173-182.

Cassista, G. "Improvement in a child with attention deficit hyperactivity disorder, kyphotic cervical curve and vertebral subluxation undergoing chiropractic care." *J Vert Sublux Res* 5 (2009): 1-11.

Wittman, R., Vallone, S., & Williams, K. (2009). Chiropractic management of six-year-old child with attention deficit hyperactivity disorder (ADHD). *J Clin Chiropr Pediatr*, *10*, 612-620.

Bedell, L. "Successful care of a young female with ADD/ADHD and vertebral subluxation: a case study." *J Vert Sublux Res* 7 (2008): 3-9.

Young, Antoinette. "Chiropractic management of a child with ADD/ADHD." *J Vert Sublux Res* (2007): 1-4.

Lovett, Lisa, and Charles L. Blum. "Behavioral and learning changes secondary to chiropractic care to reduce subluxations in a child with attention deficit hyperactivity disorder: a case study." *Journal of Vertebral Subluxation Research* 1.6 (2006).

Elster, E. "Upper cervical chiropractic care for a nine-year-old male with Tourette syndrome, attention deficit hyperactivity disorder, depression, asthma, insomnia, and headaches: a case report." *Journal of Vertebral Subluxation Research* 1.11 (2003).

Hoffman N, Russell D. Improvement in a 3½-year-old Autistic Child Following Chiropractic Intervention to Reduce Vertebral Subluxation. J. Vertebral Subluxation Res. March 24, 2008, pp 1-4.

McCormick, J. "Positive behavioral changes following chiropractic care in a child diagnosed with autism." *J Clin Chiropr Pediatr* 9.1 (2008): 553-7.

Marini, N., and S. Marini. "Improvement in autism in a child coupled with reduction in vertebral subluxations: A case study & selective review of the literature." *J Pediatr Matern & Fam Health* 3 (2010): 107-15.

Rosen, M. G., and C. L. Blum. "SOT chiropractic care of a 6-year-old boy diagnosed with Asperger's syndrome and related conditions." *J. Pediatric, Maternal & Family Health* (2010): 267-268.

Scelfo, T. A., and P. L. Chelenyak. "Resolution of autistic symptoms in a child undergoing chiropractic care to correct vertebral subluxations: a case study." *J Pediatr Matern & Fam Health* 31 (2011): 106-10.

Handt, M. "Improvement in a child with pervasive developmental disorder undergoing chiropractic care." *J Pediatr Matern & Fam Health* (2011): 5-8.

Allison Noriega, D. C., D. C. Jonathan Chung, and D. C. Justin Brown. "Improvement in a 6 year-old Child with Autistic Spectrum Disorder and Nocturnal Enuresis under Upper Cervical Chiropractic Care." *spine* 16: 17.

Pellegrino, A. Improvements in a 4-year-old with autism spectrum disorder following chiropractic care to reduce vertebral subluxation [case report]. J Pediatr Matern & Fam Health - Chiropr. 2016 Spring;2016(2).

Pappicco M. Improved health outcomes and quality of life in a 10-year-old child with autism spectrum disorder following chiropractic care to reduce vertebral subluxation: A case study and selective review of the literature [case report, review]. J Pediatr Matern & Fam Health - Chiropr. 2018 Mar;2018.

Russell, D. "Improvement in behavior, communication & sociability in a child with autism following chiropractic care for vertebral subluxation: a case report and review of the literature." *Journal of Pediatric, Maternal & Family Health, Chiropractic* (2018): 40-48.

Cleave, J., et al. "Improvement in autistic behaviors following chiropractic care: a case series." *J Pediatr Matern & Fam Health Chiropr* 4 (2011): 12-13.

Lerner, B., and S. Lerner. "Improvement in learning and speech disorder in a child with vertebral subluxations undergoing chiropractic care: a case study." *Journal of Pediatric, Maternal & Family Health–Chiropractic* 4 (2009): 1-7.

Marietta, G. A. "An Epidemiological Approach to the Effects of Subluxation Based Chiropractic Care on a Child with Autism, Acid Reflux, Headache, Seizures, and Vomiting: A Case Study and Review of the Literature."

Eric Jaszewski, D. C. "Improvement in Idiopathic Scoliotic and Sub-Scoliotic Curvatures in Children Following Subluxation Correction Utilizing the Pierce Results System: A Retrospective Analysis of Outcomes."