HAAVIK CHIROPRACTIC

2014

# How to Confidently Communicate the Science of Chiropractic
# An Introductory Workshop

Dr Heidi Haavik

*In association with:*

NEW ZEALAND COLLEGE OF CHIROPRACTIC

graduating hands, hearts & minds

*"Wisdom is experiential; it is a truth one recognizes in the external world that already resides in the internal one. Knowledge gives you the tools to obtain insight/wisdom, but never mistake the tools for the treasure.*

*One is known, the other felt. It awakens within as an all encompassing flood of warm illumination or like a bolt of lightning that shocks or stuns you. This is why the sages call it enlightenment.*

*Wisdom does not need digesting, deliberating, debating or dissecting by doubt or reason. It breathes within you as 'calm surety' and 'perfect peace'. It is then that you recognize intellectually that this knowledge has always been with you, just waiting for you find it. From head to toe, you have everything you need to become extraordinary.*

*There is wisdom in Nature and knowledge in Scholarship. Nature teaches us what works and what doesn't work. Knowledge teaches us how to use our senses, how to observe nature, how to evaluate it, how to record life lessons, and how others before us did the same.*

*We first learn wisdom in life by experience, (usually painful experience) and then as we grow, we recognize wisdom in life by example. Through knowledge and wisdom, we eliminate fear, which produces understanding. We begin to understand who we are and why we are here."*

***Ardriana Cahill***

*"No Science bursts forth complete on its first formulation. It must make its slow advance from fact to theory and hypothesis, thence back to more facts to be explained by the same theory, or as amended or new theory. No science is ever a completed one because new facts, new relations, and new phenomena are forcing themselves upon consciousness, seeking for classification and explanation in conformity to the laws under which they exist.* ***We need wide-awake, up-to-date Chiropractors. Art and Science have no enemies but those who are ignorant****."*

***B.J. Palmer***

This full day workshop has been created for you, the practicing chiropractor, the chiropractic student, and the chiropractic assistant to help you gain an understanding about the chiropractic-relevant neurophysiological research that has been conducted over the past decade and a half. Some of the information I provide may be totally new for you, because some of the information has only been discovered in the past two decades. I have tried to present this material in a user friendly manner, with practical exercises for you to help understand the material. After working through this workshop you should be able to more confidently communicate the mechanisms of chiropractic care to the public, your patients and other health care providers in a respectful manner and using information that is congruent with the latest scientific understanding. The knowledge you will gain is the absolute latest understanding about how the brain works, and how chiropractic care likely impacts brain function of our patients.

This booklet is fully referenced for you so you can access any further readings you would like. The references are also there for you so that this document and all of my claims within it are fully open to scrutiny or formal evaluation by anyone who may wish to do so. I have in my opinion presented a fair picture of what I believe to be the mechanisms of chiropractic care, based on the summation of my combined experience as a chiropractor and a neuroscientist.

*Heidi Haavik*

## About the author

Dr Heidi Haavik is a chiropractor and a neurophysiologist who has worked in the area of human neurophysiology for the past ten years. She has utilised techniques such as somatosensory evoked electroencephalography and transcranial magnetic brain stimulation to investigate the effects of chiropractic adjustments of vertebral subluxations on somatosensory processing, sensorimotor integration and motor cortical output.

Dr Haavik graduated from the New Zealand College of Chiropractic in 1999, and was awarded her PhD degree by the University of Auckland in 2008. She is currently the Director of Research at the New Zealand College of Chiropractic where she also runs the newly established Centre for Chiropractic Research.

Dr Haavik is also an Adjunct Professor at the University of Ontario, Institute of Technology in Oshawa, Canada and is a member of the World Federation of Chiropractic's Research Council. Dr Haavik has received numerous research awards and has published a number of papers in chiropractic and neurophysiology journals.

She has presented her work to both chiropractic and neuroscience communities around Australasia, North America and Europe. She is on the Editorial Board of the Journal of Manipulative and Physiological Therapeutics and Journal of Chiropractic Education. She was named Chiropractor of the year in 2007 by both the New Zealand Chiropractic Association and the New Zealand College of Chiropractic Alumni Association.

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# Table of Content

## Learning outcomes with this Workshop

**At the end of this introductory workshop the learners should be able to:**

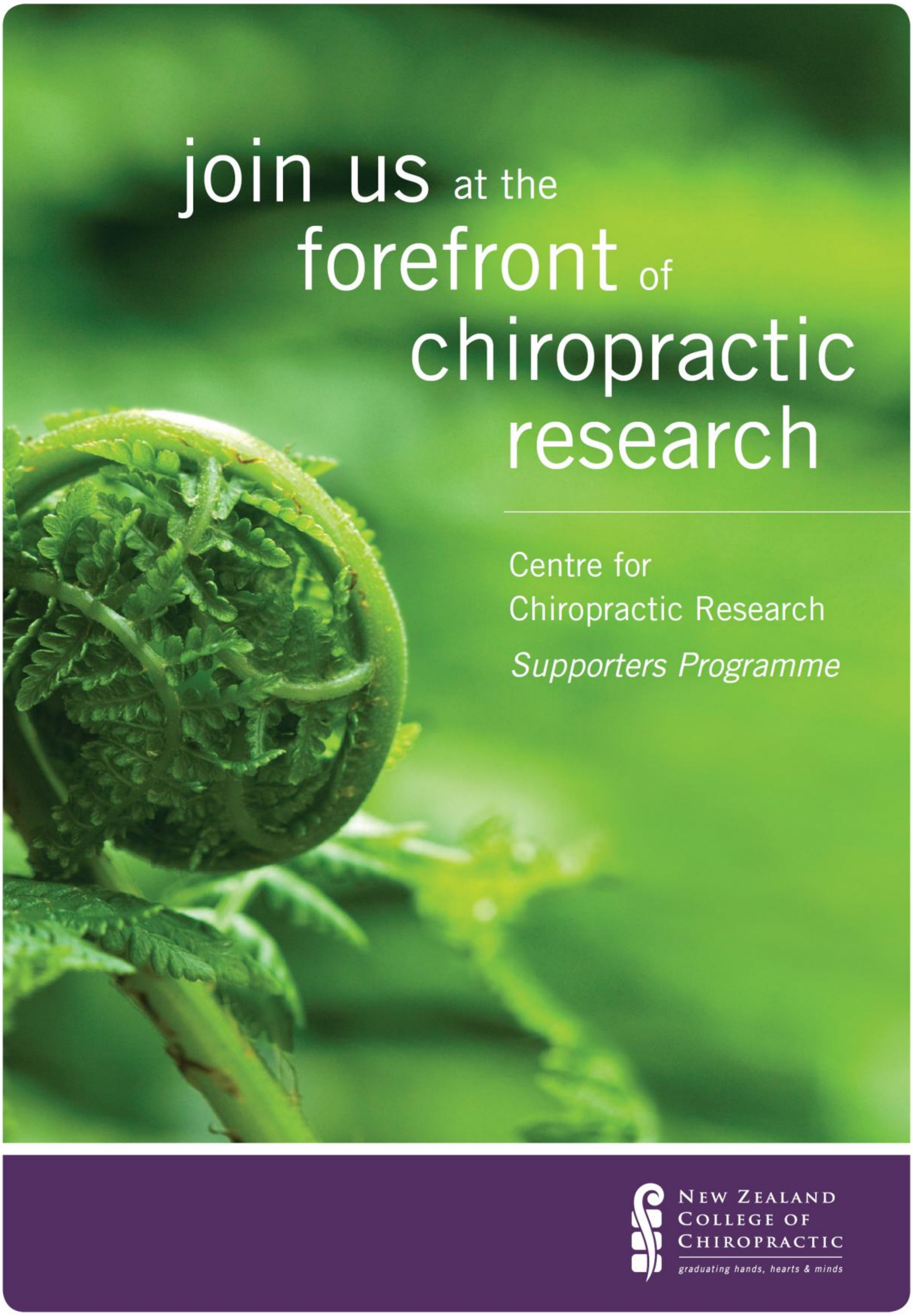
- Be able to answer simple questions from their patients about the types of basic science neurophysiology research relevant to the vertebral subluxation concept and chiropractic care.
- Summarise and communicate with patients about the latest theories of how spinal function impacts human neurophysiology.
- Summarise and communicate with patients about the latest theories of how chiropractic and manipulative care impacts human neurophysiology.
- Summarise some research methodologies, and describe what differentiates them and discuss what the purpose of these different research methodologies are.
- Summarise how the central nervous system integrates afferent information and how it adapts to its ever-changing environment (i.e. neural plasticity) in both an adaptive and mal-adaptive way.

## A Note up front about the clinical construct know as the Subluxation

Over the past decade and a half our research group has conducted a variety of research experiments that have added to our understanding of the central neural plastic effects of adjusting the spine [1-7]. The specific segments that chiropractors chose to adjust can usually be described as segments that have muscle tightness, tenderness upon palpation over the joint and restricted palpable intersegmental movement. However, the aberrant segmental spinal movement patterns we detect may also display as hypermobility at particular segments. These various aberrant segmental movement patters are what some of us in the chiropractic profession call a "vertebral subluxation." Other professions may use different names such as "spinal fixation", or "vertebral (spinal) lesion", or "somatic dysfunction" [8].

For the purposes of this workshop, the "manipulable lesion" or the articular dysfunction component of the chiropractic clinical construct, i.e. also known as the vertebral subluxation, may either be referred to as an area of aberrant spinal movement, spinal dysfunction or joint dysfunction or a subluxation or a vertebral subluxation. I have used these terms interchangeably. Please forgive me if you dislike one of these terms. From a research perspective, I am fascinated by and interested in understanding the effect we have on the central nervous system when we adjust a so called subluxation. In the research literature, joint dysfunction definitions include experimentally induced joint effusion [9], pathological joint disease such as osteoarthritis [10], as well as the more subtle functional alterations that are commonly treated by manipulative therapists [11, 12].

I know this topic may be contentious for the profession. However, as a scientist I have spent the past ten plus years of my life trying to understand what it is and what effect we have when we adjust it. I hope you can put aside any political concerns and work through this workshop from this same place of curiosity about what it is we do.


join us at the
forefront of
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research
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The Centre for Chiropractic Research is dedicated to pioneering research that investigates the full potential of chiropractic care and gives greater validity to the profession. Help us to lead the way by joining our Centre for Chiropractic Research Supporters Programme.

Contact Dr Kelly Holt, if you would like to join the Supporters Programme or for more information.
Phone: +64 9 526 2104
Email: kelly.holt@nzchiro.co.nz

# Practical Exercises

## Self Reflection – Where are you at now?

Write down how you currently explain:

1. What chiropractic is

___________________________________________________________________________
___________________________________________________________________________
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2. What a subluxation is

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## Self Test

In the next five minutes list the seven components of the scientifically valid explanation about how chiropractic care works. Explain each component as best you can in this time:

1. ____________________________________________________________
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## Constructive Peer Review Feedback Form for Active Learning Session

*Do they include the following components, and did they give a simple example of each, note what was missing and please provide constructive feedback.*

*Name of participant:* ________________________________

| Components: | Tick if discussed | Tick if simple example included: | Note what may have been missed: | Constructive feedback: |
|---|---|---|---|---|
| Neuroplasticity – Can be good and bad | | | | |
| Inner brain reality / body schema | | | | |
| Subconscious processing | | | | |
| Brain fills in the gaps & filters afferent info | | | | |
| Paraspinal muscles are SENSORS | | | | |
| What happens if spinal segments don't move properly (too much or too little) | | | | |
| What happens when we adjust these segments | | | | |
| Use of Poster | | | | |
| Use of Pamphlet | | | | |

## Self test about research methodology

| Question | Basic Science | Clinical Science |
|---|---|---|
| 1. How can you tell the difference between basic science and clinical science? What evidence do each provide? | | |
| 2. Can you think of some difficulties scientist have when doing research into the subluxations and effects of adjusting them? | | |
| 3. What is the key difficulty when trying to do clinical science with a chiropractic intervention? | | |
| 4. What is the benefit to you with good chiropractic basic science? | | |
| 5. What is the benefit to you with positive chiropractic clinical science? | | |

## Second Self Reflection – Where are you at now?

Consider what you have learnt and again write down how you now may wish to communicate:

1. What chiropractic is

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______________________________________________________________________________
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2. What a subluxation is

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## The blind spot test

**Instructions:**

a) Close your left eye and stare at the cross mark in the diagram with your right eye. Hold the brochure close to your face. You should be able to see the spot.
b) Don't LOOK at it; just notice that it is there off to the right. Keep your eye focussed on the cross. Now slowly move the brochure away from you.
c) Keep looking at the cross mark while you move the brochure slowly further away. At a particular distance (probably a foot or so), the spot will disappear (it will reappear again if you move even further away).
d) The spot disappears because it falls on the spot where the optic nerve head enters the eye, which is basically a hole in the photoreceptor sheet at the back of the eye.
e) So, as you can see, you have a pretty big blind spot, at least as big as the spot in the diagram. What's particularly interesting though is that you don't SEE it. You don’t see a blind spot. What you see is something the brain is making up.

# NOTES FOR PARTICIPANTS

## The Matrix Story

If you have seen the movie the Matrix you will remember Thomas Anderson who is a computer programmer who also maintains a double life as the hacker "Neo". He is intrigued by the cryptic references to "the Matrix" that appear on his computer. He meets up with the infamous hacker Trinity who informs him that a man named Morpheus can tell him what the Matrix is. However, there are three Agents, led by Agent Smith, who is out to stop them. They arrest Neo to prevent this. Undeterred, Neo meets with Morpheus and confirms that he wants to learn more about the Matrix by choosing an offered red pill. After swallowing the pill, Neo abruptly awakens in a liquid-filled vessel. His body is pierced with cables that connect him, along with billions of other people, to an elaborate electrical network. From this place he is rescued by Morpheus and brought aboard a levitating ship, called the *Nebuchadnezzar*.

Morpheus tells Neo that humans are fighting against intelligent machines that were created in the 21st century and have since taken control of the Earth's surface. Humans polluted the sky to cut off the machines' solar power, but the machines adapted to using human bioelectricity as a power source. Enslaved humans are kept docile within the "Matrix" – a simulation of the world as it was in 1999. Neo has lived in this simulated world since birth; in reality, the year is closer to 2199.

Morpheus explains that he and his crew belong to a group of free humans who "unplug" others from the Matrix and recruit them to their rebellion against the Machines. So basically Neo's whole life has been a simulation, a lie, created by the intelligent machines plugging into his central nervous system.

## How does this relate to chiropractic?

Our brains basically create our own virtual reality or 'matrix' via our five senses. Through our five senses our brain computes all the sensory information and integrates this with its own wishes and desires, carries out a whole lot of background processing that we are not generally aware of and creates for us a virtual reality in our minds about what is going on in our own bodies and the world around us.

Since the inception of chiropractic, patients have reported improvements in areas of nervous system function following chiropractic adjustments of their spine. Understanding how this might occur is of essential value to the profession, our patients and the public at large. Better scientific explanations for how chiropractic care improves function will have far reaching effects on scope of practice, funding for and access to, chiropractic care.

Scientists now understand that when the nervous system is subjected to unaccustomed inputs, changes occur in the way the system processes all subsequent inputs [13-20]. This ability of the nervous system to change the way it responds has been termed "neural plasticity". Research has shown that neural plasticity partially explains how people can recover function after damage to the nervous system, such as the damage that occurs with strokes. Over the past ten years several research groups have demonstrated that spinal adjustments can change various aspects of nervous system function including muscle reflexes, reaction time and the speed at which the brain processes information. We have been heavily involved in this type of work, and will cover this in greater detail in the next part of this workshop.

We hypothesise [2, 21, 22] that maladaptive neural plasticity occurs as a result of segments in the spine that are not moving in an ideal manner. This will be what some of us call a vertebral subluxation. We have further argued that through spinal adjustments we can restore normal movement patterns in these spinal segments and therefore restore a more natural pattern of afferent nerve input from the spine to the central nervous system. This in turn will allow the (spinal cord, brainstem and) brain to process incoming information in a more coherent and meaningful way. This provides a potential mechanism by which spinal adjustments of dysfunctional spinal segments can improve nervous system function, as observed daily in chiropractic practices all around the world.

To understand this better I will now cover some of the basic science discoveries about how the brain and central nervous system works and link this with greater detail to what I have outlined above regarding the mechanisms of chiropractic care.

## Paraspinal muscles and muscle spindles

One key component in the proposed theory about the neurophysiological mechanisms of chiropractic care [2, 21, 22] is the functional role of paraspinal muscles. To understand this you need to understand the role of the muscle spindle. I will therefore cover the basics of this here.

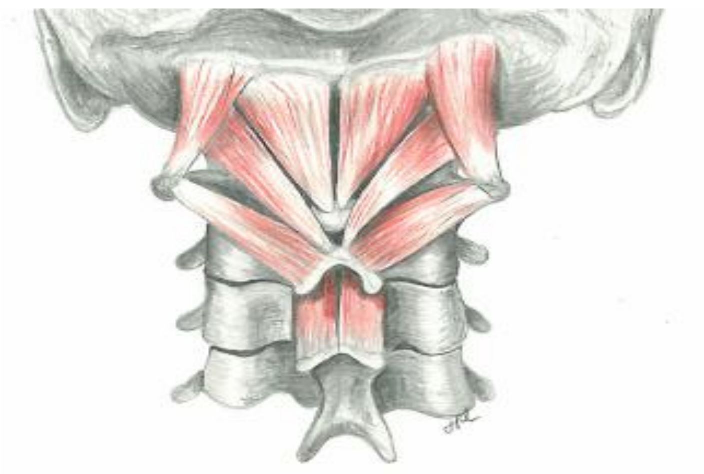

**Figure 1: Image of the deep upper cervical sub-occipital paraspinal muscles [23]**

If you have forgotten the basics about the muscle spindle I would recommend you check out the following links. This first one is a basic video about the muscle spindle, stretch reflexes and alfa-gamma interactions. http://www.youtube.com/watch?v=4vgf0uVkg5U Muscles spindles play an important role in sensorimotor integration and most likely play a very important role in the mechanisms of chiropractic care. Sensorimotor integration means the brains ability to integrate the sensory information it receives and adapt the motor command (muscle response) based on this sensory information to for example perform 'perfect' movements (i.e. without making mistakes).

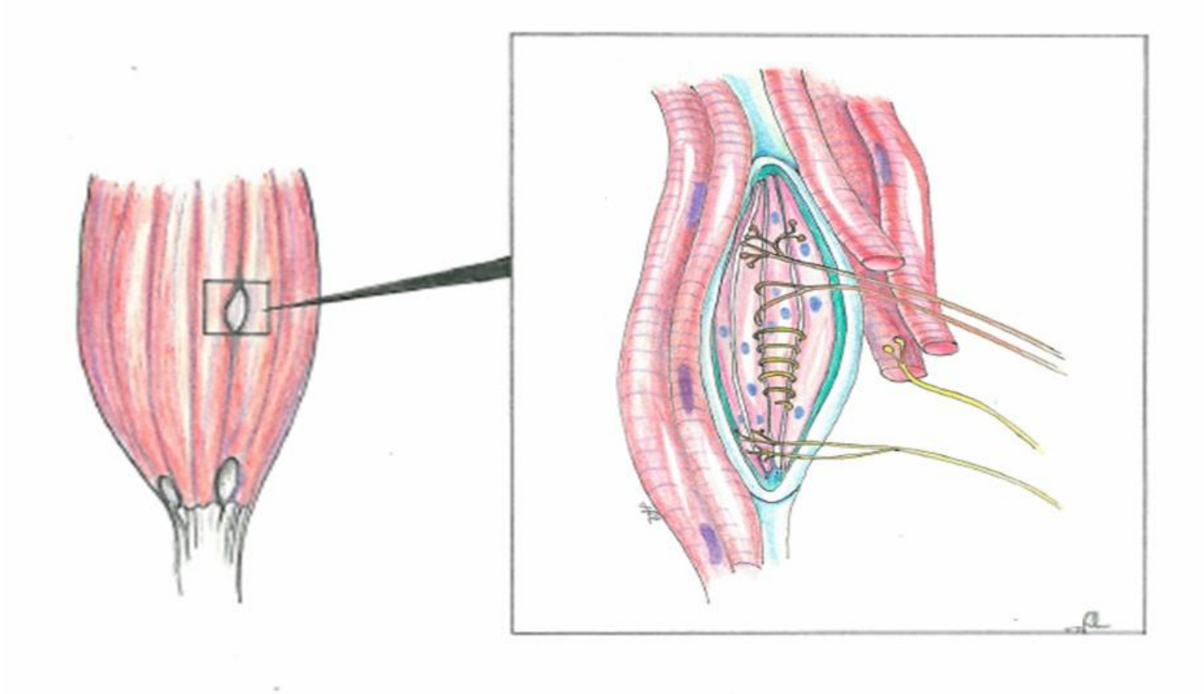

**Figure 2: Image of the muscle spindle**

Scientists have shown that the number and density of muscles spindles are remarkably high in the upper cervical or subocciptial deep paraspinal muscles [24-27]. This has led some of them to suggest the functional role of the deep paraspinal muscles is to act more as propriocpetive sensors as opposed to playing any significant role in movement. One group that has studied the number and density of muscle spindles commented that because these sub-occipital muscles are very small they seem incapable of bringing about any significant head movement [25]. The same authors also argued that they have a mechanical disadvantage because they are inserted very close to the craniovertebral joints, as compared to the large powerful rotators of the head, like trapezius and splenius muscles, which are multisegmental and inserted laterally [25]. Biomechanically, large superficial muscles have substantially greater moment-generating capacities than their smaller and deeper counterparts. Furthermore these authors have argued that due to their very high proprioceptive content this make them ideal candidates to act as sensors of joint position and movements of craniovertebral joints [25]. Boyd-Clarke and colleagues have similarly suggested that from a proprioceptive perspective, the small muscles required for fine motor control have large spindle densities, whereas those recruited for gross movement are comparatively devoid of spindle density [24]. Also because the small sub-occipital muscles have almost no tendon organs [25], this suggests that these muscles are functionally incapable of sensing contractile tensions, but sense length changes and thus the movement only. These authors [25] also point out that kinesthetic information from the suboccipital muscles are likely to be handled in a very complex way due to the known convergence of vestibular, oculomotor, visual and neck proprioceptive inputs at various levels of the neuroaxis. However, as Boyd-Clarke and colleagues have also highlighted, spindle characteristics represent only one aspect of many factors contributing to proprioceptive regulation in skeletal muscle [24]. Another important factor worth mentioning is motor unit density.

## The chiropractic adjustment and effects on spindle activity

When we apply our adjustive thrust to the spine this is likely to stretch the paraspinal muscles. Pickar et al [28] have shown that muscle spindles and golgi tendon organs with receptive endings in the paraspinal muscles in anesthetised cats respond to vertebral loads whose force-time profiles are similar to that of a load delivered during spinal manipulation [29]. And Herzog and colleagues have shown that spinal manipulation thrusts can evoke short lasting electromyographic (EMG) responses recorded from paraspinal skeletal muscle [30, 31]. Paraspinal spindle reflexes could contribute to the short lasting EMG responses recorded from the paraspinal skeletal muscles.

Bolton et al. [32, 33] developed an animal model for studying in vivo central effects of vertebral displacement, and have shown that such displacement may be signalled to the central nervous system by afferent nerves arising from deep intervertebral muscles. In particular, both the velocity and relative position of the vertebral displacement appeared to be encoded by afferent nerve activity from intervertebral muscles. Furthermore, afferent nerves innervating the zygapophyseal joints did not contribute significantly to the signalling of vertebral displacement [32]. This work supports the theory that joint dysfunction or vertebral subluxations leads to altered input from deep intervertebral muscle afferents to the CNS.

It is well known that the CNS continuously reorganises in response to altered peripheral input [13-20]. This input can be an increase in peripheral input (known as hyperafferentation), such as with repetitive muscular activity [14, 34-39], or increased sensory input such as in blind Braille readers [40]. However, this type of CNS reorganisation can also occur following a decrease in behaviour or activity (known as deafferentation) [17, 41-47]. Knowing this we hypothesised that a subluxation, which reflects altered spinal segmental movement patterns, is likely to alter the afferent input from the deep paraspinal muscles (e.g. such as muscle spindle input) to the CNS which may lead to ongoing maladaptive plastic changes, and that we restore a more appropriate afferent input to the CNS by adjusting these dysfunctional segments and restoring the appropriate segmental movement patterns [2, 21, 22]. According to this the subluxation can be viewed as a self-perpetuating central segmental motor control problem that leads to ongoing maladaptive central plastic changes.

## Sensorimotor integration and neural plasticity

Our central nervous system (CNS) is continuously adapting to an ever-changing environment. This ability to adapt is known as neural plasticity. It is now well understood that the CNS can reorganise in response to altered peripheral input [13-20]. It can do so following increased peripheral input (hyperafferentation), such as with repetitive muscular activity [14, 34-39] or increased sensory input such as occurs with blind Braille readers [40]. On the other hand a similar CNS reorganisation may take place due to a decrease in behaviour or activity (deafferentation), such as during transient deafferentation or ischemia [17, 41-47]. These changes are thought to be due to alterations in the strength of internal connections, representation patterns, or changes in the structure or function of neurons [48, 49].

Every second of every day our CNS continuously monitors and integrates all incoming sensory information. This allows it to accurately formulate and execute the motor commands it requires based on what you choose to do at any one point in time. This integration of sensory information to accurately perform movements is known as sensorimotor integration. Throughout life our particular activities and behaviour will lead to specific molecular, biochemical, electrophysiological and structural changes in our central nervous system. These changes are the physiological mechanisms for learning, memory, and recovery from injury [37, 44, 49, 50].

These central nervous system changes may occur rapidly (short term changes), within minutes to hours [45], or may occur over longer periods of time (long term changes), such as with chronic deafferentation [51, 52], amputation [17, 53-55], or with motor training [56, 57]. Plastic changes are not limited to the cerebral cortex either. They have also been demonstrated in subcortical structures such as the thalamus [58], various brainstem structures [51, 54, 59-61], and in the spinal cord [51, 54, 59].

## Chiropractic and sensorimotor integration

Dysfunctional spinal segments, or what many of us call subluxations, are likely to lead to abnormal afferent input to the CNS. This abnormal afferent input may represent additional background noise or a lack of spinal afferent input. If the spinal segment is stuck and not moving it will not be stretching the muscles spindles in the segmental paraspinal muscles and hence there will be a less muscle spindle (propriocepetive) information arriving at the brain. These changes in afferent input may be the cause of maladaptive neural plastic changes that potentially can lead to pain and various syndromes.

For example it is known that older adults appear to filter less background sensory information, meaning they experience more baseline 'noise', resulting in greater integration of sensory information than younger adults, even when they are selectively attending to a sensory stimulus [62, 63]. Increased background sensory noise is not considered a good thing [63]. Increased background sensory noise may become a problem or cause distractions for individuals that can lead to accidents, particularly if stimuli from different modalities are incongruent [64].

In Part 4 below I will cover in greater detail the numerous research studies our research group have carried out over the past decade and a half that have added to our understanding of the central neural plastic effects of adjusting the spine [1-7]. However, to get full use of this knowledge you will need to understand the neurophysiological concepts behind this research. If you do not have a good grasp of the physiology behind neural plasticity and sensorimotor integration please refer to the additional readings section.

The study of sensorimotor integration is vital to improve our understanding of normal physiological function, as well as to provide important insight into how and when plasticity of the sensorimotor system malfunctions. A better understanding of these maladaptive plastic changes will help to unravel the complex interactions occurring when a spine is not functioning properly, and could shed light on how best to provide appropriate relevant chiropractic care for these patients.

## Maladaptive neural plasticity, pain, dysfunction, spinal function and potential role of chiropractic care

There is a lot of research evidence that demonstrates there is significant cortical plastic changes present in a variety of musculoskeletal pain syndromes [65, 66]. Patients with mechanical low back pain display alterations in the way their brains recruit their trunk muscles compared with people who do not have low back pain [67-69]. Abnormal neuromuscular patterns, such as altered feed-forward postural adjustments, have been demonstrated in a variety of musculoskeletal conditions including anterior knee pain [70], low back pain [71], and idiopathic neck pain [66]. Basically the brain will normally send a message to other muscles than the ones you yourself consciously want to move. It does this to stabilise your body. But for the pain conditions mentioned above the brain is not sending these so called feed-forward messages, and therefore not stabilising the body, which in itself is likely to worsen the persons condition. It pretty much makes their problem self-perpetuating.

Some scientists have hypothesised that these changes in muscle recruitment patterns are an adaptation (i.e. maladaptive plasticity) to underlying spinal instability resulting from osteoligamentous laxity or damage, muscle dysfunction or reduced neuromuscular control [72, 73]. In my opinion segmental dysfunction or subluxations may well be the osteoligamentous laxity that Panjabi talks about. And as discussed earlier I view a subluxation as a central segmental motor control problem, in other words a muscle dysfunction or reduced neuromuscular control problem.

There is actually evidence in the literature to suggest that muscle impairment occurs early in the history of onset of spinal complaints [74], and that such muscle impairment does **not** automatically resolve even when pain symptoms improve [74, 75]. This has led some scientists to suggest that the deficits in proprioception and motor control, rather than the pain itself, may be the main factors defining the clinical picture and chronicity of various chronic pain conditions [76, 77]. I would therefore argue that segmental spinal dysfunction (or the subluxation) represents segmental motor control deficits that alter propriocpetive input to the brain and CNS, and that they are in themselves a significant problem that can negatively impact the development and perpetuation of various chronic pain conditions.

We know from recent publications that chiropractic care (involving spinal manipulation of dysfunctional or subluxated segments) can alter neuromuscular and proprioceptive function in patients with neck and back pain as well as in asymptomatic subjects. For instance cervical spine manipulation was shown to produce greater changes in pressure pain threshold in lateral epicondylalgia than thoracic manipulation [78], and in asymptomatic patients lumbar spine manipulation was found to significantly influence corticospinal and spinal reflex excitability [79]. Interestingly, Soon et al. did not find neurophysiological changes following mobilisation on motor function and pressure pain threshold in asymptomatic individuals [80], perhaps suggesting that manipulation, as distinct from mobilisation, induces unique physiological changes.

There is also accumulating evidence to suggest that chiropractic care can result in changes to central nervous system function including reflex excitability, cognitive processing, sensory processing, and motor output [81-85]. There is evidence in subclinical neck pain individuals that chiropractic adjustments alter cortical somatosensory processing [2, 86] and elbow joint position sense [81]. This evidence suggests that chiropractic adjustments have a positive neuroplastic effect on the central nervous system and this therefore means that adjusting subluxations in these individuals may play a positive role in the treatment of neck pain by improving the accuracy of proprioceptive processing.

I believe that improving our understanding of the neurophysiological mechanisms of chiropractic care may help prevent the development of chronic neck pain in individuals with subclinical neck pain. I hope to be able to provide objective neurophysiological markers of altered sensory processing that could help to determine if an individual is showing evidence of disordered sensorimotor integration, and thus might benefit from early intervention to prevent the progression of sub clinical neck problems into more long-term or chronic pain states.

## The Research Model

Based on our research findings over the past 15 years we have proposed that areas of spinal dysfunction represent a state of altered afferent input which may be responsible for ongoing central plastic changes [2, 21, 22]. Furthermore, we have proposed a potential mechanism which could explain how chiropractic adjustments can improve function and reduce symptoms. We have proposed that altered afferent feedback from an area of spinal dysfunction alters the afferent "milieu" into which subsequent afferent feedback from the spine and limbs is received and processed, thus leading to altered sensorimotor integration (SMI) of the afferent input, which is then normalised by high-velocity, low-amplitude spinal adjustments [2, 21, 22]. This processing (i.e. sensorimotor integration), is a CNS function that appears vulnerable to altered input from spinal afferents [2, 21, 87].

Over the next two Workshops I will provide you with an overview of some of the growing body of research on the effects of chiropractic care on sensory processing, motor output, functional performance and sensorimotor integration. This body of work contributes to our understanding of how an initial episode(s) of back or neck pain may lead to ongoing changes in input from the spine, which over time leads to altered sensorimotor integration of input from the spine and limbs. Increasing this understanding may provide a neurophysiological explanation for some of the beneficial clinical effects reported by chiropractors and other manipulative therapists in day to day practice.

One of the aims with our research in the long run is to identify objective neurphysiological markers which may be able to predict which patients will respond best to chiropractic care and/or whether a patient has had a sufficient amount of chiropractic care to normalise neurophysiological markers of disordered sensorimotor integration. It may be that patients do not have enough chiropractic care (i.e. drop out of care too early) and that this may lead to the reoccurrence of problems that could be avoided, or that we could prevent problems from becoming chronic in the first place. With the growing burden that musculoskeletal pain syndromes places on our lives and on our health care systems, this is an important area for future research.

The research that we have been conducting all relates to the overarching research model shown below.

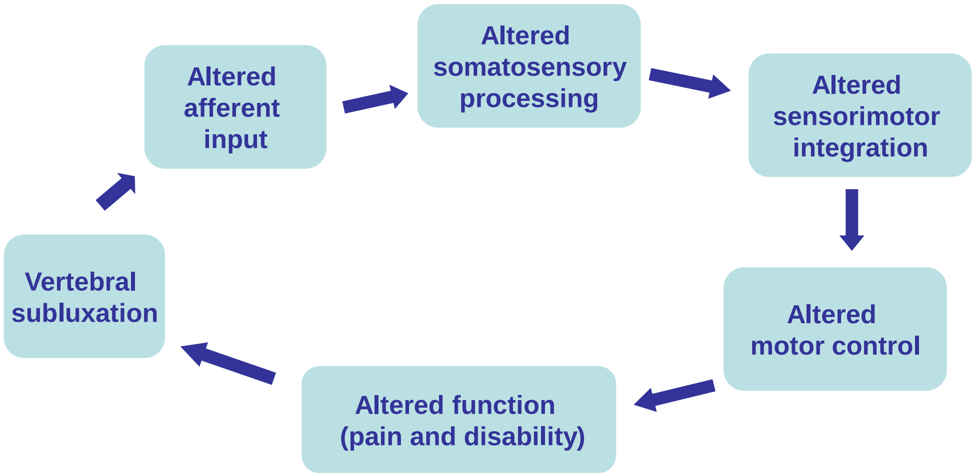


**Figure 5: The effects of spinal dysfunction or subluxation on central neural function**

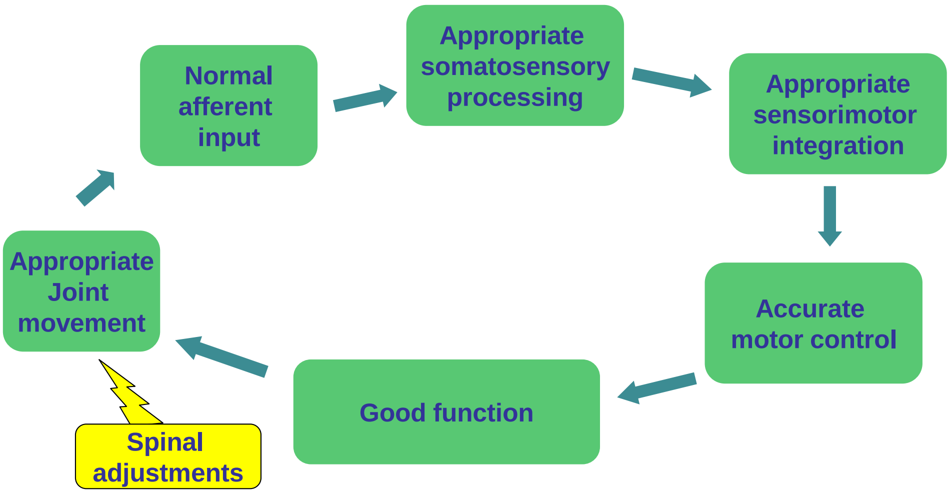


**Figure 6: the hypothesises effect of adjusting dysfunctional or subluxated spinal segments on central neural function.**

This model is important for the chiropractic profession because there is a growing body of evidence that demonstrates a significant effect of chiropractic adjustments on the function of many sensorimotor systems and processes for recent review see [21]. For example, chiropractic adjustments have been reported to improve or alter visual acuity and visual field size [88, 89], joint position sense error [90], reaction time [91], cortical processing [2, 91], cortical sensorimotor integration [2, 4, 5], reflex excitability [11, 12, 92, 93], motor control [4, 7, 94], and lower limb muscle strength [95]. Our theory and the above model provides a potential explanation for the link between chiropractic care and these changes in sensorimotor function [21, 96].

Numerous studies have demonstrated that chiropractic care improves spinal function [97-102]. This is important because spinal impairments are known to result in reduced postural control [77, 87, 103-112]. The link between cervical function and postural control has been well documented in cases of chronic neck pain, neck muscle fatigue, cervicobrachial pain syndrome, cervical root compression, cervical myelopathy, head injury and whiplash injury [77, 87, 104, 105, 107-111]. Recently an association between cervical osteoarthritis and postural stability has also been reported [103]. It therefore appears that there is a strong link between cervical function and accurate proprioceptive processing, and thus postural control. The low back has also been implicated in poor postural control as patients with low back pain or lumbar disc herniation exhibit increased postural sway [113, 114]. This again suggests a central processing change due to an alteration in afferent input. The work of Zhu et al. [115, 116], who investigated alterations in somatosensory evoked potentials (SEP's), suggests that this central processing change could be due to a decrease in the amplitude of the actual neural signal generated from areas of "muscle spasm" in patients with chronic low back pain. This group found decreased SEP amplitudes evoked from magnetic stimulation of the "spasmed" muscle, which returned to normal following successful treatment with joint manipulation. Murphy and Dawson [93] have previously demonstrated improvement in intramuscular discrimination following local trigger point therapy to the forearm musculature which demonstrates that local musculoskeletal treatment can improve central processing of somatosensory input.

Many of the studies we have conducted over recent years investigating this potential relationship between vertebral subluxations and altered CNS function for recent review see [21] focussed on subclinical pain populations. Subclinical pain (SCP) refers to recurring dysfunction such as mild pain, ache, and/or stiffness with or without a history of known trauma. Individuals with SCP do not have constant symptoms and have not yet sought treatment for their neck complaint. There is an increasing interest in SCP in the literature because individuals that fall into this category provide an opportunity to explore neurophysiologic dysfunction without the confounding effect of current pain, which is known to alter sensory processing and motor control [117]. Another reason why this particular group is interesting is because it is thought that gaining a better understanding of the features characterising this group may help improve sub-grouping of actual pain patients. The scientists who explore this group (such as us) also wish to be able to identify objective brain markers that reflect altered sensory processing that could aid in determining those individuals showing evidence of disordered sensorimotor integration who may need an intervention to prevent the progression of neck pain to more long-term pain states [118]. Such brain markers could also be used to determine if an intervention is working and for how long such an intervention may be required.

## Science 101

According to the New Zealand Tertiary Education Commission, research is:

> "...original investigation undertaken in order to contribute to knowledge and understanding and, in the case of some disciplines, cultural innovation or aesthetic refinement.
>
> It typically involves enquiry of an experimental or critical nature driven by hypotheses or intellectual positions capable of rigorous assessment by experts in a given discipline.
>
> It is an independent, creative, cumulative and often long-term activity conducted by people with specialist knowledge about the theories, methods and information concerning their field of enquiry. Its findings must be open to scrutiny and formal evaluation by others in the field, and this may be achieved through publication or public presentation."

Science is basically a method or tool to be able to better understand the world we live in. My particular area of interest in science has been to understand HOW chiropractic care works. I chose to do this using the scientific method because it can have important implications for the whole profession, and the public, because it is formal, rigorous, and open to scrutiny and formal evaluation. High quality research about the mechanisms of chiropractic care has the potential to influence public opinion and policy makers regarding scope and access to chiropractic care. As a profession I believe we are seriously lacking in high quality research. However, it has been pleasing to see this issue being addressed over the past decade. Over the past ten years we have finally seen the trickling in of a growing body of good quality science relating to chiropractic care. I hope that along with this increase in available research findings, that we will become better consumers of this literature, and that we make the effort to up-skill in science literacy. We are not alone in this regard, as it is well acknowledged that most health professionals are not as good as they ideally should be in being evidence informed in their practice.

## Evidence-Based Chiropractic

Evidence-Based Chiropractic (EBC) is a method of practice where a chiropractor integrates research evidence into clinical practice. It involves the chiropractor combining the best available research evidence with their clinical expertise and the desires and preferences of the patient to help make clinical decisions. It is an off-shoot of evidence-based medicine (EBM) or evidence-based practice (EBP) which evolved from clinical epidemiology. It aims to bridge the gap between clinical practice and public health using population health sciences to inform clinical practice. Dr David Sackett, a clinical epidemiologist and medical doctor from McMaster University in Canada, is often said to be one of the forefathers of EBM. When discussing EBM Dr Sackett has said:

> *"Evidence-based medicine is the conscientious, explicit and judicious use of current best evidence in making decisions about the care of individual patients. The practice of evidence-based medicine means integrating individual clinical expertise with the best available external clinical evidence from systematic research. By individual clinical expertise, we mean the proficiency and judgment that we individual clinicians acquire through clinical experience and clinical practice. By best available external clinical evidence, we mean clinically relevant research, often from the basic sciences of medicine, but especially from patient-centered clinical research into the accuracy and precision of diagnostic tests, the power of prognostic markers and the efficacy and safety of therapeutic, rehabilitative and preventive regimens. External clinical evidence both invalidates preciously accepted diagnostic tests and treatments and replaces them with new ones that are more powerful, more accurate, more efficacious, and safer.*
>
> *Good doctors use both individual clinical expertise and the best available external evidence and neither alone is enough. Without clinical expertise, practice risks becoming tyrannized by external evidence, for even excellent external evidence may be inapplicable to or inappropriate for an individual patient. Without current best external evidence, practice risks becoming rapidly out-of-date, to the detriment of patients."* [119, p.71-72]
>
> *EBP is criticised by some who describe it as a 'cookbook' approach to healthcare. This is not what EBP is when applied properly. It is supposed to involve a* "bottom up approach that integrates the best external evidence with individual clinical expertise and patient's choice, it cannot result in slavish, cookbook approaches to individual patient care. External clinical evidence can inform, but never replace, individual clinical expertise, and it is this expertise that decides whether the external evidence applies to the individual patient at all and, if so, how it should be integrated into a clinical decision." [119, p.72]

Unfortunately the principles of EBP may be hijacked and bastardised to create practice guidelines that may be interpreted as "rules" or "prescribed procedures" that limit the subjective discretion of the practitioner. Guidelines are often created in an attempt to reduce costs to third party payers and do not always respect the role that clinical experience and the patients desires in the clinical decision making process. This is not the case for all practice guidelines, but this usurpation of clinical experience has created animosity from some in the chiropractic profession towards evidence-based practice.


Figure 1: The Evidence-based Practice Triad

Other criticisms of EBC may be based on the common view that the placebo controlled double blind randomised controlled trial (RCT's) and systematic reviews are the only acceptable evidence to consider. As can be seen in the diagram below these research designs are considered to be the highest levels of clinical evidence on the hierarchy of evidence, but very few good quality, large scale RCT's that investigate the effectiveness of chiropractic care have been conducted.

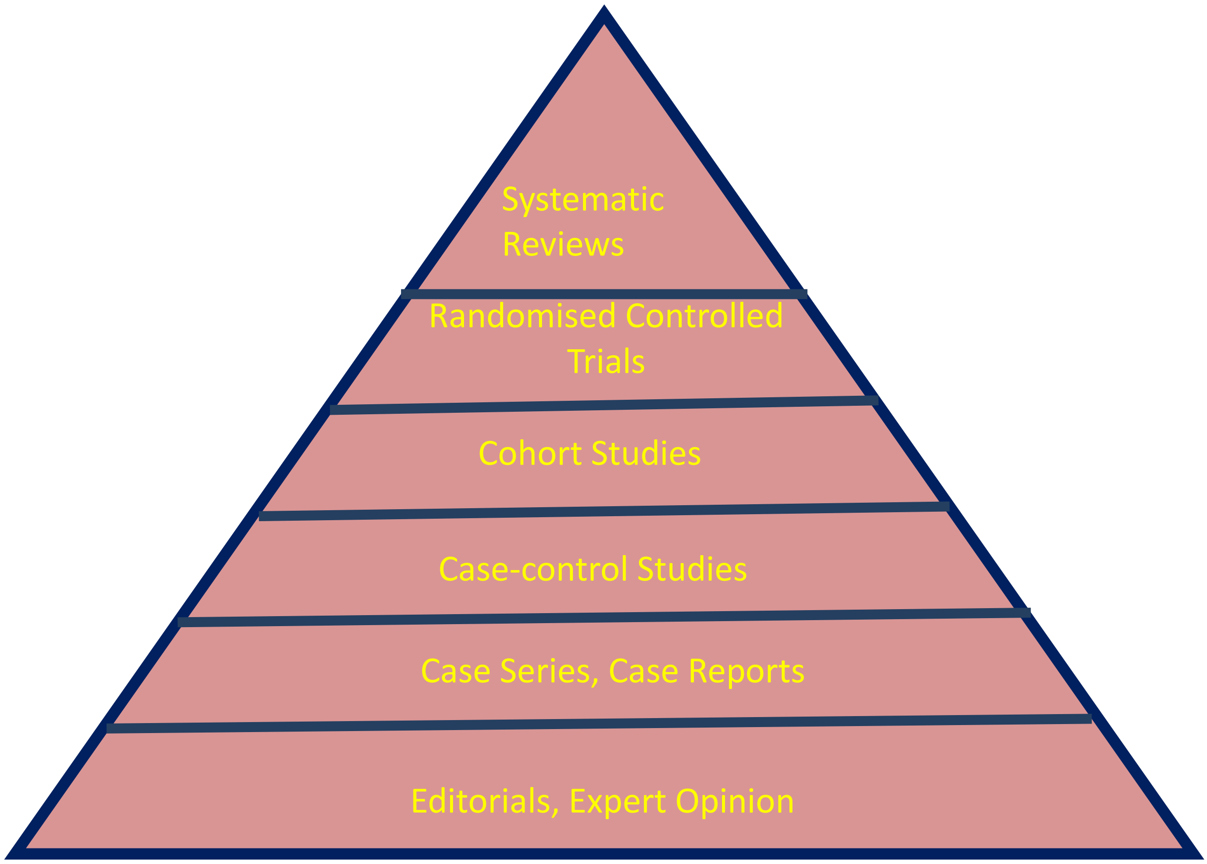


Figure 2: The Hierarchy of Evidence

If no RCT's are relevant to a particular patient's presentation then lower levels of evidence should be utilised. However, some proponents of EBC argue that if high levels of relevant evidence do not exist then a chiropractor should not provide care to the patient. However, an absence of evidence is not evidence of absence! Chiropractic clinical epidemiological research is still in its infancy, therefore appropriate studies just may not have been done. It should also be remembered that just because an RCT failed to find an effect of an intervention it does not mean the intervention does not 'work'. It may simply mean that the study design was not appropriate to demonstrate that an effect exists. Absence of evidence should not be a reason to withhold chiropractic care if appropriate studies have not been done!

"However, an absence of evidence is not evidence of absence!"

Another criticism of EBC is epidemiological evidence is based on the study of populations and may be inappropriate to apply to an individual patient. Clinical research is often based on specific presentations or specific conditions and may exclude participants with comorbid conditions or non-classic presentations. This often results in studies that have little external validity, meaning the results may not be able to be generalised because many 'real world' patients were excluded from the study. The results of RCT's also reflect 'averages' of groups. This may mean some participants showed an excellent response to an intervention but by averaging the results these 'responders' were lost and the results became insignificant. If this is the case, until potential 'responders' can be identified it may be inappropriate to integrate the results of such an RCT into practice.

## When to use EBC

EBC becomes important when situations arise for which the chiropractor does not have adequate answers. In other words their clinical expertise is incomplete or lacking. This may involve a patient who presents with a disorder that the chiropractor has not encountered before and requires modification to their usual case management practices. It may also involve challenging issues around patient safety, referral or co-management. In situations like these, a chiropractor may choose to turn to the best available research evidence to help make clinical decisions as opposed to guessing what to do or simply referring their patient to another healthcare provider. But as a profession do you think we have the skills to do this? Do you know how to access the scientific information you need to help your patients make informed decisions about choosing chiropractic care? This course is designed to re-cap the basics you will have learnt in College and update you about the latest knowledge relating to the neurophysiological mechanisms of chiropractic care and how best to communicate this information to your potential patients, existing patients, the public and other health care providers. For some of you this will be simple stuff that you already know, but for those of you that have been in practice for a long time this may need some reading and reflecting.

The end goal will be that you can comfortably talk to anyone with confidence about the known mechanisms of chiropractic care, and that will you understand the basics of science and the research that supports what you do. You may even find that you might need to change a few things in regards to how you practice, to further benefit your patients. That is what scientific understanding and evidence based chiropractic is all about.

## Research Methodology

The following is some basic information to consider regarding the many different research methodology designs. As I explained in the PowerPoints the various methodologies are a bit like different rooms of a house, each with their own purpose and each having their own requirements. Your role as an evidence informed chiropractor is to be able to tell what type of different studies you have found relating to your clinical question, and be able to critically evaluate that literature according to the correct evaluation guidelines for each particular study. For example if you are looking at a study that belongs in the living room (e.g. a clinical trial) then you will need to critically evaluate that study according to the living room criteria (e.g. see checklist relating specifically to a clinical trial in Appendix 1). I.e. there would be no point in looking for a bed or a toilet in the living room. In exactly the same way different research methodologies have different requirements and there are different checklists or evaluation lists available for you to evaluate different kinds of studies. It would obviously be no good evaluating an apple according to an orange rating scale unless you have come across an apple like this one.

## The Research Question

If you can figure out the research question from any study you are reading this will usually give away the type of study it is, or at least the type of study it should be. For the purposes of this booklet I am going to stick to a few types of research methodologies only.

**NOTE in very simple terms basic science experimental designs usually want to answer questions about HOW something works, i.e. mechanisms.**

**NOTE also in very simple terms Clinical Research (Randomised Controlled Clinical Trials; RCTs) usually want to answer questions about whether an intervention is effective in treating a particular condition or syndrome, i.e. DOES the intervention or treatment work for condition X, Y or Z.**

## Translational science and the role of basic science evidence.

Translational research is scientific research that helps to make findings from basic science useful for practical applications that enhance human health and well-being. Scientists practicing translational research strive to transform basic science laboratory discoveries into new or better therapies for patients. It can take more than a decade, however, before a basic scientific finding can advance through preclinical and clinical studies to result in a new therapy, clinical device or prevention method. However, this is the ultimate goal with translational research. In a chiropractic setting this has been lacking, particularly because our basic science research has been lacking. Therefore there was very little to translate. Instead, most chiropractic researchers jumped on the clinical research wagon trying to determine what conditions chiropractic care treated best.

# Test yourself on your ability to talk about this research1

**First an Example for you:**

Do keep in mind that when talking about research findings with patients it is best to take the conservative approach, and explain 3 things. 1) What research has been done, 2) what this potentially means to your patient, and 3) then caution them about the limitations with this particular research.

For example pretend you recently had read the full paper by Haavik & Murphy 2011. Here is the abstract so you know briefly what this paper was about:

**Abstract**

Objective: The objectives of this study were to investigate whether elbow joint position sense (JPS) accuracy differs between participants with a history of subclinical neck pain (SCNP) and those with no neck complaints and to determine whether adjusting dysfunctional cervical segments in the SCNP group improves their JPS accuracy.

Method: Twenty-five SCNP participants and 18 control participants took part in this pre-post experimental study. Elbow JPS was measured using an electrogoniometer (MLTS700, ADInstruments, New Zealand). Participants reproduced a previously presented angle of the elbow joint with their neck in 4 positions: neutral, flexion, rotation, and combined flexion/rotation. The experimental intervention was high-velocity, low-amplitude cervical adjustments, and the control intervention was a 5-minute rest period. Group JPS data were compared, and it was assessed pre and post interventions using 3 parameters: absolute, constant, and variable errors.

Results: 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

[1] Model answers are in the back of this booklet

that adjusting dysfunctional cervical segments in people with SCNP can improve their upper limb JPS accuracy.

If you had a patient who was very clumsy with her left arm (who also had fractured the radius and ulnar in a skiing accident the previous year), who had reoccurring neck problems and wanted to know if chiropractic care may help her, and you enthusiastically wanted to tell her about the Haavik et al (2011) study that demonstrated improved elbow joint position sense in subclinical neck pain patients this is an example of what you could say: " (1) scientists have shown that when a chiropractor adjust people who have reoccurring neck problems and poor neck function they were better able to control the position of their arm. (2) This may mean that if we improve the function of your spine your arm will be less clumsy. (3) However since you also fractured your arm last year there could be other reasons why you may be more clumsy with your left arm, so it's unclear if you can expect to get similar results as the subjects in this study."

## Question 1

You have recently come across this abstract:

> **Abstract**
> **Objectives:** To determine the incidence of delayed feed-forward activation (FFA) times in a group of healthy young males; to retest those subjects who showed delayed FFA after 6 months to determine the reliability of the measure in the absence of treatment or injury in the intervening period; and to determine the effect of sacroiliac joint manipulation on delayed FFA times.
> **Methods:** Ninety young males were assessed for the FFA of their deep abdominal muscles in relation to rapid upper limb movements. Those who met the criteria for delayed FFA (failure of deep abdominal activation within 50 milliseconds of deltoid activation) were then reassessed 6 months later. These subjects then underwent sacroiliac joint manipulation on the side demonstrating decreased joint movement during hip flexion and lateral flexion. Feed-forward activation times were then reassessed after joint manipulation.
> **Results:** Seventeen (18.9%) of 90 subjects met the criteria of impaired FFA. Thirteen of 17 were available to be remeasured at 6-month follow-up. The intraclass correlation coefficient for FFA at this time was greater than 0.70 for all movement directions. There was a significant improvement (38.4%) in FFA times for this group when remeasured immediately after the sacroiliac joint manipulation.
> **Conclusions:** Delayed FFA is a highly reproducible measure at long-term follow-up. This technique appears to be a sensitive marker of the neural effects of sacroiliac joint manipulation. Future prospective studies are needed to determine if delayed FFA times are a marker for those at risk for developing back pain.

You have not yet had a chance to read the whole paper but intend to of course. The next day you have a new patient/client who is a cricketer, a fast bowler. The last couple of seasons he's developed back pain throughout the season. This year he's come to you to help him to try to avoid the back pain so he can play through the season. At the moment he is not in pain but is worried he will again develop pain this season.

A) How would you explain in simple terms what these researchers did and what they found?

| |
|---|
| |

B) How would you relate this to your patient?

| |
|---|
| |

C) What limiations, if any, are there with drawing conlcusions from this study and relating them to this patient?

**Q2:** Why does it hurt here in my low back but you are adjusting up here in my neck?

**Q3:** Why does it feel like my brain is not working before you adjust my neck?

**Q4:** Why do I keep banging my arm on the door handle?

**Q5:** Why do I keep kicking my little toe on the door and then you adjust me and I stop doing it?

**Q6:** How come my golf score is better after you adjust me?

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## Model Answers to Self Test Questions

**Question 1**

A) A study was performed that involved young cricketers and looked at their ability to stabilise their spine and trunk while moving their arms, as they would have to do when bowling. This study was really interesting because the researchers found that some of them couldn't stabilise properly, and this lack of stability over the last six months during which they went about their daily living. It is thought that people with this lack of stability are more likely to develop back pain. When the researchers adjusted their lower backs they were better able to stabilise their backs straight away after that single adjustment. If something like this is happening with you, it may mean that if we improve the function of your lower back you'll be better able to stablise your spine which could reduce your chance of reinjuring it. You've got to remember that this was only a short term study so it's unclear how long these improvements lasted for, but if you're back isn't moving well it could be one reason why you're developing pain throughout the season."

B) It may be that you also lack this ability to stablise your spine when you bowl and that this is why you develop low back pain during the season.

C) More studies are needed to determine if this lack of stability does mean you are at risk for developing back pain, so this may or may not be why you develop back pain. (NOTE from me; such studies have now been conducted and there is evidence that suggests those with delayed FFA times are predisposed to develop low back pain – and I will cover this more in future workshops). I also dont know if you do lack this ability to stabilise your spine so I dont know if this relates to you specifically. And we don't know how long this effect lasts or if you would need to get adjusted regularly for this effect to last all season.

**Q2:** I am checking your spine for segments that are not moving properly and I adjust the ones that don't move properly because our neuroscientists suggest that these segments can cause altered signals to the brain which change the way it senses other incoming information. This may alter the way your brain senses what is going on in your body and the environment so that it is less able to accurately perceive what is going on and respond appropriately. It's also possible that the problems I'm addressing I your neck are affecting the way the muscles in your low back are controlled by your brain, and the way your brain senses what is going on in your lower back.

**Q3:** Our neuroscientists have shown that when we adjust dysfunctional (subluxated) segments that this can alter the way your brain processes sensory information, the way it integrates this information and the way it controls your body. This may be why you feel like your brain works better after you get adjusted.

**Q4:** Our neuroscientist have shown that if we adjust dysfunctional (subluxated) spinal segments that it can improve your brains ability to know where your elbow is, so this may be why you stop banging your arm on the door handle after you get adjusted.

**Q5:** Our neuroscientist have shown that if we adjust dysfunctional (subluxated) spinal segments that it can improve your brains ability to know where your elbow is, so this may also be the case for feet, but we dont know that yet, and this may be why you stop kicking your little toe after you get adjusted.

**Q6:** Our neuroscientist have shown that if we adjust dysfunctional (subluxated) spinal segments that it can improve your brains ability to know where your elbow is, can change the way your brain integrates sensory signals from your body and change the way it sends messages to your muscles in your hands. This may be why your golf score is better after you get adjusted. They think that when we adjust these dysfunctional (subluxated) segments that it improves the communication between your brain and your body, so that it can more accurately perceive what is going on in the environment  and respond more appropriately.