How to Implement the Contemporary Brain Model of Chiropractic Care in practice
SATURDAY
Heidi Haavik BSc (chiropractic), PhD
VP Research, Dean Research
New Zealand College of Chiropractic

1

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2

www.heidihaavik.com
Gifts
Gifts
Keep your Spine Moving
The HANDOUT for today's Class (the slides)

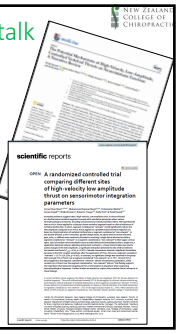
3

Key References for today's talk

Heidi Haavik, Nitika Kumari, Kelly Holt, Imran Khan Niazi, Imran Amjad, Amit N. Pujari, Kemal Sitki Türker, Bernadette Murphy. (2021a) The contemporary model of vertebral column joint dysfunction and impact of high-velocity, low-amplitude controlled vertebral thrusts on neuromuscular function. Invited Review. European Journal of Applied Physiology. https://doi.org/10.1007/s00421-021-04772-7

Heidi Haavik, Imran Khan Niazi, Nitika Kumari, Imran Amjad, Jenna Duehr, Kelly Holt. (2021b) The potential mechanisms of High-Velocity, Low-Amplitude, Controlled Vertebral Thrusts on Neuroimmune Function: A narrative review. Medicina 2021, 57, 536. https://doi.org/10.3390/medicina57060536

Imran Khan Niazi, Muhammad Samran Navid, Christopher Merkle, Imran Amjad, Nitika Kumari, Robert J. Trager, Kelly Holt, Heidi Haavik. 2024 A randomized controlled trial comparing different sites of high-velocity low amplitude thrust on sensorimotor integration parameters. Scientific Report. 14(1), p.1159 https://www.nature.com/articles/s41598-024-51201-8



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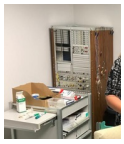
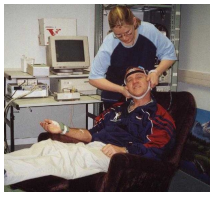
1999 NZCC Graduate





2008 PhD

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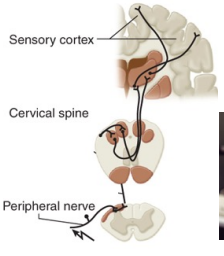
5

Somatosensory Evoked Potentials

Number of pulses = 1000
Frequency = 2.3 Hz
Length = 0.2 ms
Intensity = 1 mA above the stimulation intensity that elicited clear twitch of the thumb.



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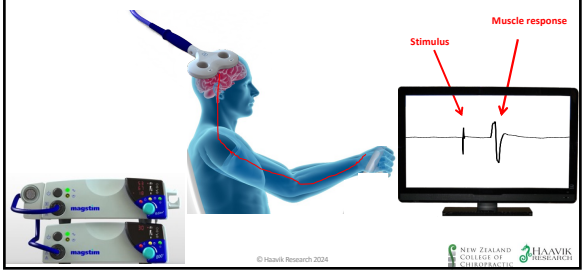
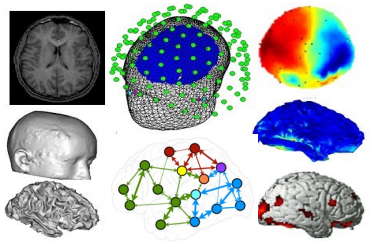
Transcranial Magnetic Brain Stimulation



7

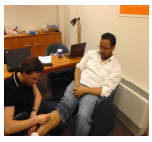
Electroencephalography (EEG)

- SEPs
- Resting State
- Source localization analysis
- Connectivity analysis

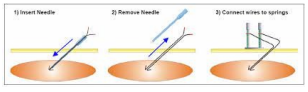


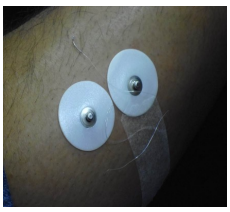
8

Our Intramuscular EMG studies



we were able to record 85 single motor units (using the needle-based technique) across 19 participants

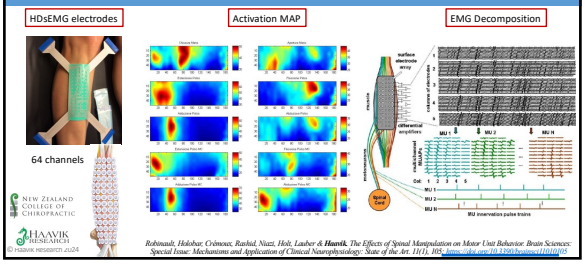




Haavik H, Niazi IK, Jochumsen M, et al. Chiropractic spinal manipulation alters TMS induced I-wave excitability and shortens the cortical silent period. J Electromyogr Kinesiol 2018;42:24-35. doi: 10.1016/j.jelekin.2018.06.010

9

High Density Surface Electromyography (HDsEMG)



Robinault, Holobar, Crémoux, Rashid, Niazi, Holt, Lauber & **Haavik**. The Effects of Spinal Manipulation on Motor Unit Behavior. Brain Sciences: Special Issue: Mechanisms and Application of Clinical Neurophysiology: State of the Art. 11(1), 105. https://doi.org/10.3390/brainsci11010105

10

500 channel HDsEMG and 3D motion capture

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- Biomechanics by using 3D motion analysis system
- 500 High Density EMG over erector spinae muscles

NCMIC

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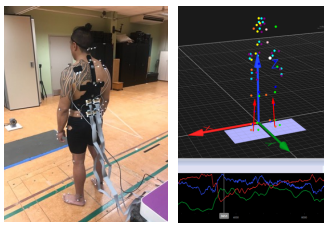

Robinault, Niazi, Kumari, Amjad, Menard, **Haavik**. Non-Specific Low Back Pain: An Inductive Exploratory Analysis through Factor Analysis and Deep Learning for better Clustering. Brain Sciences. 2023 Jun 13;13(6):946.

11

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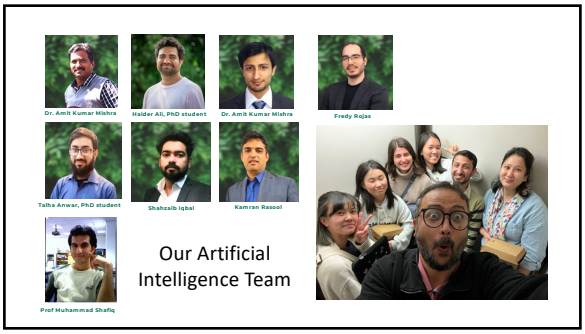
12


Dr. Amit Kumar Mishra
Haider Ali, PhD student
Dr. Amit Kumar Mishra
Fredy Rojas
Talha Anwar, PhD student
Shahzaib Iqbal
Kamran Rasool
Prof Muhammad Shafiq
Our Artificial Intelligence Team

13

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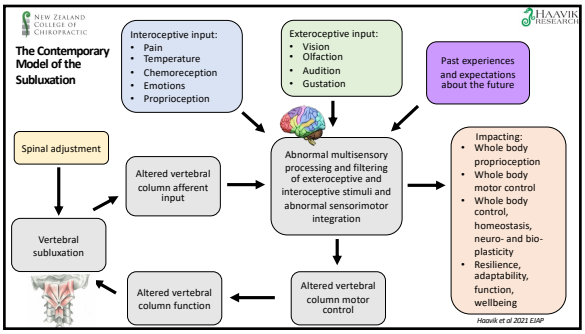
BioDesign Lab
The AUT BioDesign Lab is a transdisciplinary collaboration between engineers, designers, physiologists, neuroscientists, clinicians, businesses, and community that seeks to find effective solutions to real-life health and environmental problems, and where appropriate, translate these into commercial innovation.
Research Themes
Metabolic Health Monitoring and Modification
Augmented breathing
Wearable Sensor signal processing and Integration
Brain Signal Processing and Integration, and Artificial Intelligence
Immersive Data visualisation
e-Health technologies
Autonomic Nervous System and Biorhythm Monitoring and Modification
Musculoskeletal biomechanics and biomechatronics
Technology and human-microbe interactions

14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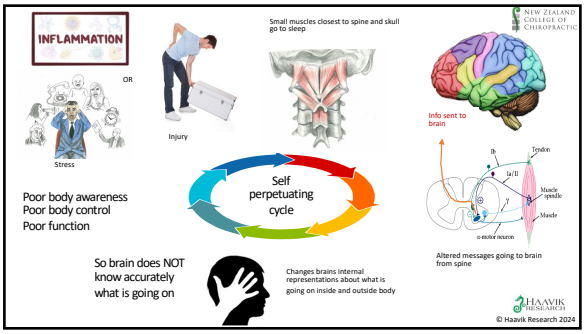
The Contemporary Model of the Subluxation
Interoceptive input:
Pain
Temperature
Chemoreception
Emotions
Proprioception
Exteroceptive input:
Vision
Olfaction
Audition
Gustation
Past experiences and expectations about the future
Spinal adjustment
Altered vertebral column afferent input
Abnormal multisensory processing and filtering of exteroceptive and interoceptive stimuli and abnormal sensorimotor integration
Impacting:
Whole body proprioception
Whole body motor control
Whole body control, homeostasis, neuro- and bio-plasticity
Resilience, adaptability, function, wellbeing
Vertebral subluxation
Altered vertebral column function
Altered vertebral column motor control
Haavik et al 2021 EJAP

15


INFLAMMATION
OR
Stress
Injury
Small muscles closest to spine and skull go to sleep
Info sent to brain
Tendon
Ib
Ia/II
Muscle spindle
γ
α
Muscle
α-motor neuron
Altered messages going to brain from spine
Self perpetuating cycle
Poor body awareness
Poor body control
Poor function
So brain does NOT know accurately what is going on
Changes brains internal representations about what is going on inside and outside body
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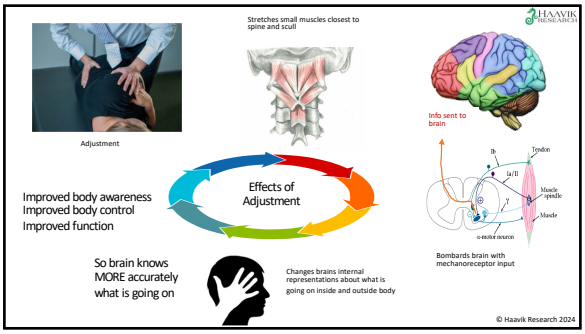
16


Adjustment
Stretches small muscles closest to spine and scull
Info sent to brain
Tendon
Ib
Ia/II
Muscle spindle
γ
α
Muscle
α-motor neuron
Bombards brain with mechanoreceptor input
Effects of Adjustment
Improved body awareness
Improved body control
Improved function
So brain knows MORE accurately what is going on
Changes brains internal representations about what is going on inside and outside body
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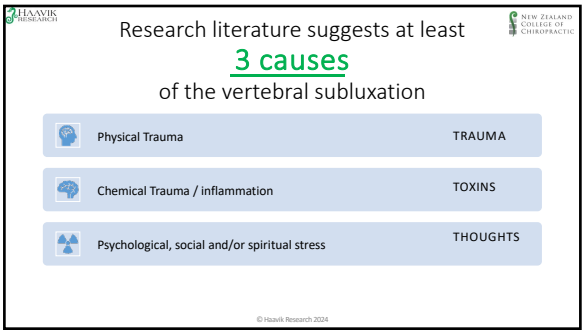
17


Research literature suggests at least
3 causes
of the vertebral subluxation
Physical Trauma
TRAUMA
Chemical Trauma / inflammation
TOXINS
Psychological, social and/or spiritual stress
THOUGHTS
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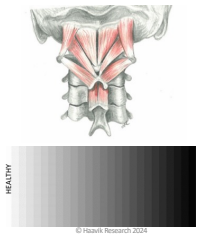
18

What happens when the spine dysfunctions?

Deep paraspinal muscles around a 'healthy' segment are:

- Plump
- Larger in size
- Slow-twitch fibre type
- No fatty infiltration
- Healthy muscle spindles
- Move freely



Subluxated segment deep paraspinal muscles over time become:

- Fibrotic
- Atrophied
- Fatty infiltration
- Change fibre type (slow to fast)
- Muscle spindles dysfunction
- DJD around joint

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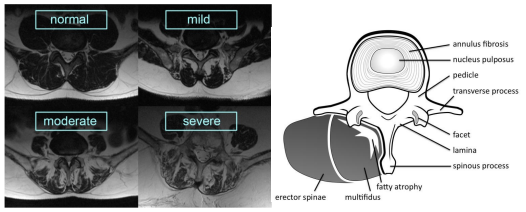
19



Faur, C., Patrascu, J.M., Haragus, H. and Anglitoiu, B., 2019. Correlation between multifidus fatty atrophy and lumbar disc degeneration in low back pain. BMC musculoskeletal disorders, 20(1), pp.1-6.

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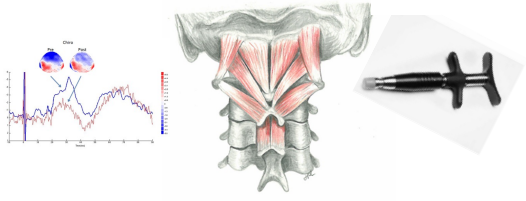
20

Does specificity matter?



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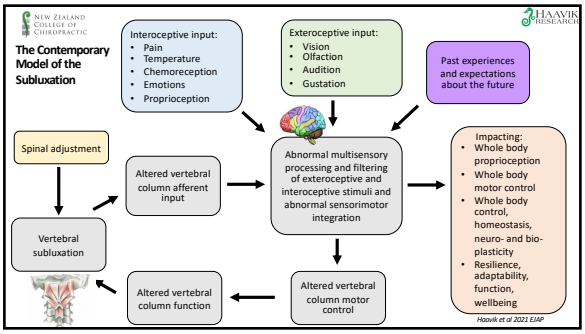
Imran Khan Niazi, Muhammad Samran Navid, Christopher Merkle, Imran Amjad, Nitika Kumari, Robert J. Trager, Kelly Holt, Heidi Haavik. 2024 A randomized controlled trial comparing different sites of high-velocity low amplitude thrust on sensorimotor integration parameters. Scientific Report. 14(1), p.1159.

21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The Contemporary Model of the Subluxation
Interoceptive input:
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• Emotions
• Proprioception
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Past experiences and expectations about the future
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Vertebral subluxation
Altered vertebral column function
Altered vertebral column motor control
Haavik et al 2021 EJAP

22

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DO YOU OWN YOUR SCIENCE?
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ARE YOU A CONFIDANT COMMUNICATOR?
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24

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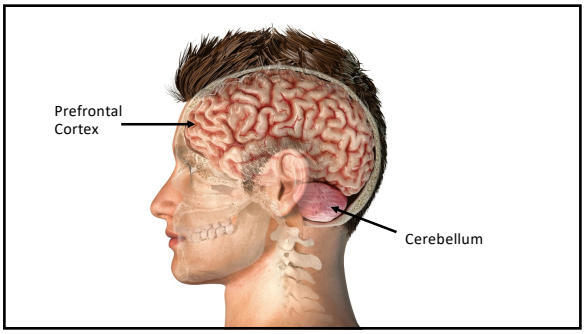
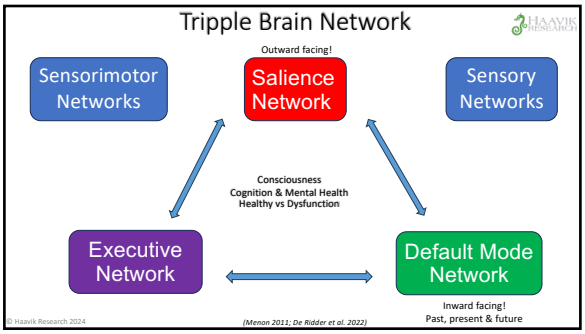
ChirosHub
All the resources for your patients and the public!
ChirosAcademy
Over 70 online classes about the science of chiropractic for you!
LearningHub
Online classes for your chiropractic assistants!

25


Prefrontal Cortex
Cerebellum

26


Tripple Brain Network
Outward facing!
Sensorimotor Networks
Salience Network
Sensory Networks
Consciousness
Cognition & Mental Health
Healthy vs Dysfunction
Executive Network
Default Mode Network
Inward facing!
Past, present & future
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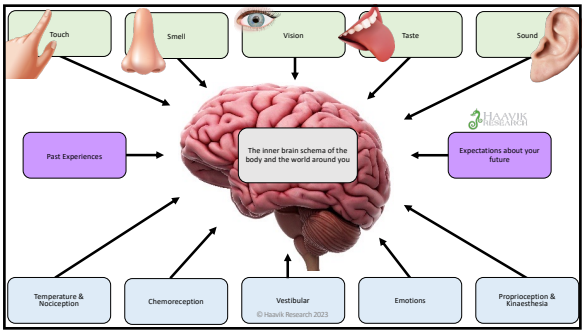
(Menon 2011; De Ridder et al. 2022)

27


Touch
Smell
Vision
Taste
Sound
Past Experiences
The inner brain schema of the body and the world around you
Expectations about your future
Temperature & Nociception
Chemoreception
Vestibular
Emotions
Proprioception & Kinaesthesia
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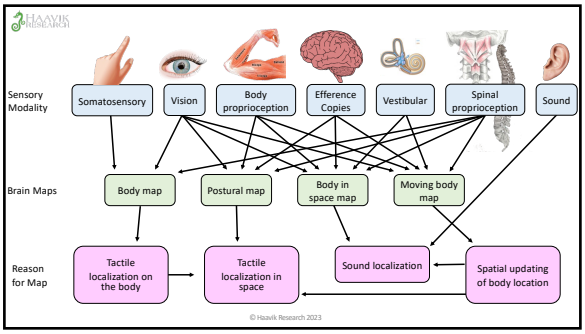
28


Sensory Modality
Somatosensory
Vision
Body proprioception
Efference Copies
Vestibular
Spinal proprioception
Sound
Brain Maps
Body map
Postural map
Body in space map
Moving body map
Reason for Map
Tactile localization on the body
Tactile localization in space
Sound localization
Spatial updating of body location
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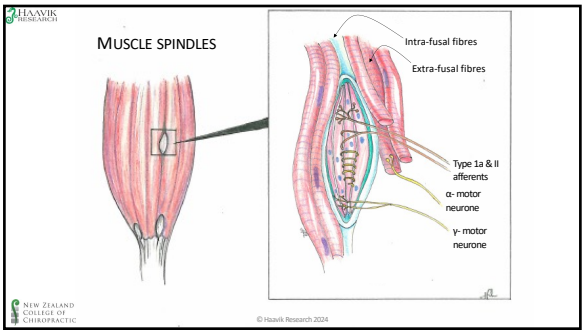
29


MUSCLE SPINDLES
Intra-fusal fibres
Extra-fusal fibres
Type 1a & II afferents
α- motor neurone
γ- motor neurone
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30

Why is all this important to understand?

Abstract

Motor control, which relies on constant communication between motor and sensory systems, is crucial for spine posture, stability and movement. Adaptions of motor control occur in low back pain (LBP) while different motor adaption strategies exist across individuals, probably to reduce LBP and risk of injury. However, in some individuals with LBP, adapted motor control strategies might have long-term consequences, such as increased spinal loading that has been linked with degeneration of intervertebral discs and other tissues, potentially maintaining recurrent or chronic LBP. Factors contributing to motor control adaptations in LBP have been extensively studied on the motor output side, but less attention has been paid to changes in sensory input, specifically proprioception. Furthermore, motor cortex reorganization has been linked with chronic and recurrent LBP, but underlying factors are poorly understood. Here, we review current research on behavioral and neural effects of motor control adaptions in LBP. We conclude that back pain-induced disrupted or reduced proprioceptive signaling likely plays a pivotal role in driving long-term changes in the top-down control of the motor system via motor *and* sensory cortical reorganization. In the outlook of this review, we explore whether motor control adaptations are also important for other (musculoskeletal) pain conditions.

Meier, M. L., Vrana, A., & Schweinhardt, P. (2018). Low Back Pain: The Potential Contribution of Supraspinal Motor Control and Proprioception. The Neuroscientist, 1073858418809074. doi:10.1177/1073858418809074

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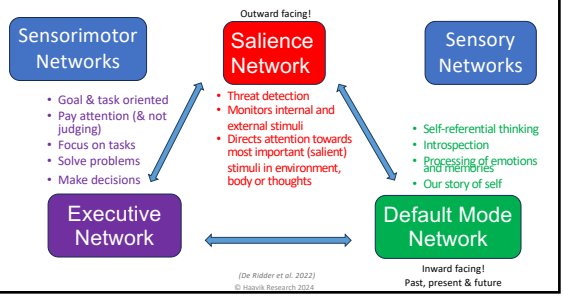
31

Tripple Brain Network & Consciousness



(De Ridder et al. 2022)

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32

Tripple Brain Network and Psychopathology

The science of large-scale brain networks offers a powerful paradigm for investigating cognitive and affective dysfunction in psychiatric and neurological disorders. This review examines recent conceptual and methodological developments which are contributing to a paradigm shift in the study of psychopathology. I summarize methods for characterizing aberrant brain networks and demonstrate how network analysis provides novel insights into dysfunctional brain architecture. Deficits in access, engagement and disengagement of large-scale neurocognitive networks are shown to play a prominent role in several disorders including schizophrenia, depression, anxiety, dementia and autism. Synthesizing recent research, I propose a triple network model of aberrant saliency mapping and cognitive dysfunction in psychopathology, emphasizing the surprising parallels that are beginning to emerge across psychiatric and neurological disorders.

(Menon 2011)

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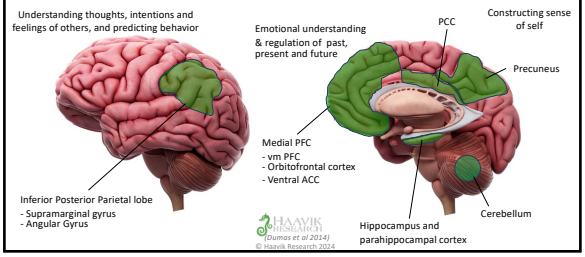
33

Default Mode Network



34

Default Mode Network

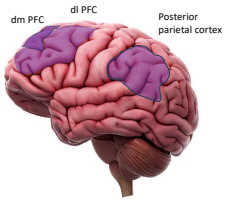
- Emotional understanding & regulation of past, present and future
- Understanding self and others' perspectives, actions and behaviours
- Internal world and awareness of self and your environment
- All about self-referential auto-pilot
- Construction of the narrative sense of self, including autobiographical memories
- Learning and consolidating everyday experiences
- Vital for consciousness

- People with Depression have Increased functional connectivity within DMN (ruminations)
- Abnormal connectivity between Salience Network and DMN in
  - Chronic Pain
  - Depression
  - Anxiety

35

Fronto-parietal (Executive Control) Network

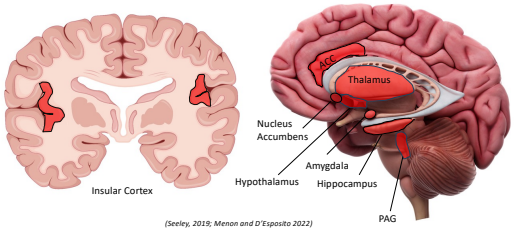
- It is Goal and Task oriented
- When you are actively engaged in a task
- Actively paying attention (and not judging)
- Capable of recruiting a wide variety of brain systems
- Multiple FP / EC networks
- Regions
  - Dorsolateral PFC
  - Dorsomedial PFC
  - Posterior parietal cortex
  - Anterior Cingulate Cortex
  - Subcortical regions



(Witt et al. 2021; Menon and D'Esposito 2022)

36

Salience Network

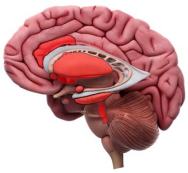


(Seeley, 2019; Menon and D'Esposito 2022)

37

Salience Network

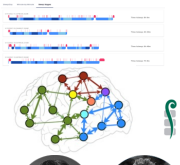
- Salience = what stands out to you, what draws your attention, most homeostaticly-relevant information at any given point in time
- Constantly scanning for threats to your survival
- Receives, assesses and responds to internal and external stimuli of both positive and negative valence
- If an event is internally appraised by your brain as an actual or potential threat to you, the event is deemed salient and attentional resources are relocated toward that event.
- Important for learning/plasticity (What you pay attention to drives plasticity)



(Seeley, 2019; Menon and D'Esposito 2022)

38

Characterising brain and muscle activation and metabolic activity changes following chiropractic care provided by a master chiropractor using whole head electroencephalography (EEG), somatosensory evoked potentials (SEPs), source localisation and near infrared spectroscopy (NIRS)-drafting manuscript



- As seen on Russell Brand show

39

As seen on YouTube in Russell Brand Interview

https://www.youtube.com/watch?v=tgwXAzTqJVU

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40

Questionnaire Study Results

Control Group

NO significant changes at all

Chiropractic Group

- Improved QOL overall
- Improved Physical function
- Less Depression
- Less anxiety
- Less Fatigue
- Less pain interference
- Less pain intensity

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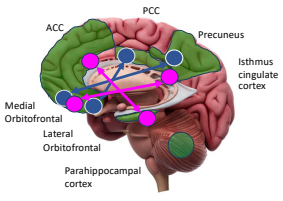
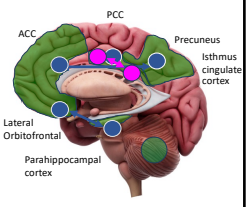
41

SEPs DMN changes

Pre and Post Chiro



Pre and Post 4 weeks Chiro



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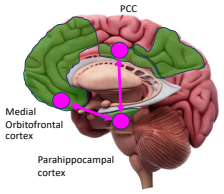
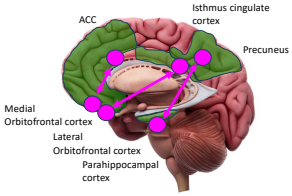
42

Resting EEG DMN changes

Pre and Post Chiro



Pre and Post 4 weeks Chiro



(Haavik et al 2024 submitted)

43

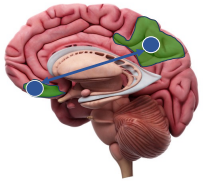
PRE vs POST First Adjustment Session

SEPs Beta ↓ R Medial-orbitofrontal - L Precuneus

May reflect the changes in body schema (and external world schema) from the spinal adjustments also altering the participants mental states, introspection and their constructed sense of self

Medial orbitofrontal

- Processing information about own mental states, beliefs, intentions and desires
- Introspection
- Construction of the narrative sense of self
- Is activated by rewarding and subjectively pleasant stimuli
- Has reduced functional connectivity in depression
- Imagines future events



Precuneus

- Self-awareness, self-referential processing and self-reflection
- Constructing sense of self
- Visuospatial integration
- Anterior Precuneus = THE HUB of Body Schema
- INCREASED in disc herniations
- Decreased following SM in disc herniation patients (Du et al 2024)

(Haavik et al 2024 submitted)

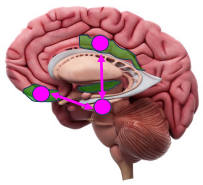
44

PRE vs POST First Adjustment Session

rEEG Alpha ↑ R Parahipp – R PCC Alpha ↑ L Parahipp – R mOFC

Most likely reflects a state of heightened introspection, emotional and spatial awareness or internally directed cognition, and improved mood after the adjustment.

- **Medial Orbitofrontal cortex**
  - Processing info about own mental state, beliefs, intentions & desires
  - Introspection and sense of self
  - REDUCED in depression
  - REDUCED in disc herniations
- **Parahippocampus**
  - Memory formation & retrieval
  - Emotional modulation of memories
  - Spatial navigation, object recognition & scene perception.



- **Posterior Cingulate Cortex**
  - Navigation & spatial memory
  - Emotional awareness and regulation
  - Construction of narrative sense of self
  - Internal, self-referencing thoughts

(Haavik et al 2024 submitted)

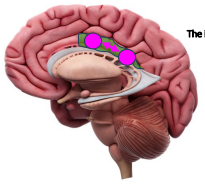
45

PRE vs POST 4 weeks of chiropractic care

SEPs Alpha ↑ L isthmus-cingulate- R PCC SEPs Alpha ↓ L PCC – R PCC

Thus, may reflect altered narrative sense of self in a manner that is reducing symptoms of depression and improvements in fatigue

- **The Posterior Cingulate Cortex**
  - internally focused, self-referential processing
  - implicated in depression
- In depression there is asymmetry in the thickness of PCC (↑ cortical thickness in left vs right)
- Depressed individuals with higher somatic symptoms (e.g. sleep disturbance, appetite disturbance, and fatigue or loss of energy) have greater asymmetry in PCC thickness



The isthmus cingulate
- introspection and self-referential processing
- construction of the narrative sense of self, including autobiographical memories

(Haavik et al 2024 submitted)

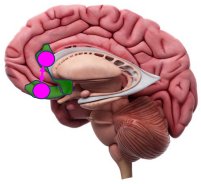
46

PRE vs POST 4 weeks of Chiropractic care

rEEG Alpha ↑ L rostral ACC – R Medial-orbitofrontal Alpha ↑ L rostral ACC - L Medial-orbitofrontal

Most likely reflects the reduction in pain and improved cognition about their own mental states and improved mood.

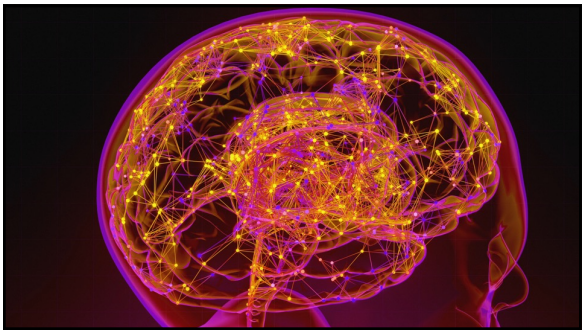
- **Medial orbitofrontal cortex**
  - Processing information about own mental states, beliefs, intentions and desires
  - Introspection
  - Construction of the narrative sense of self
  - Is activated by rewarding and subjectively pleasant stimuli
  - Has reduced functional connectivity in depression
  - Imagines future events
  - REDUCED in depression
  - REDUCED in disc herniations



(Haavik et al 2024 submitted)

- **Rostral Anterior Cingulate Cortex**
  - Recognizing, understanding and regulating own emotions
  - Appraising Interoceptive signals (visceral, emotions, pain sensations)
  - Driving physical arousal
  - Descending pain inhibitory pathway
- ACC involved in both the Salience and DMN and they have abnormal functional connectivity in people with chronic pain, depression and anxiety.

47



48

How do you incorporate this new science into practice?
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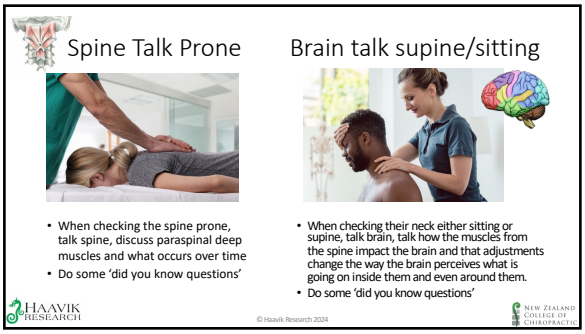
49


Spine Talk Prone
When checking the spine prone, talk spine, discuss paraspinal deep muscles and what occurs over time
Do some 'did you know questions'
Brain talk supine/sitting
When checking their neck either sitting or supine, talk brain, talk how the muscles from the spine impact the brain and that adjustments change the way the brain perceives what is going on inside them and even around them.
Do some 'did you know questions'
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50

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51

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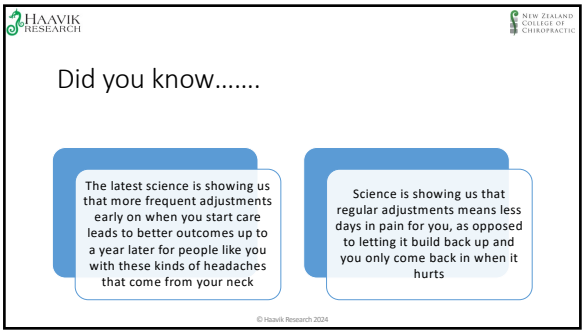
52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Did you know.....
The latest science is showing us that more frequent adjustments early on when you start care leads to better outcomes up to a year later for people like you with these kinds of headaches that come from your neck
Science is showing us that regular adjustments means less days in pain for you, as opposed to letting it build back up and you only come back in when it hurts
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53

HAAVIK RESEARCH
PA28: How Often should I see my chiropractor
ARE YOU A CONFIDANT COMMUNICATOR?
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54

55

TODAY'S HANDOUT

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Thank you!

Enlightening the world about the science of chiropractic

56