HOLD THAT THOUGHT
Reappraising the work of Dr Caroline Leaf

Dr C. Edward Pitt MBBS FRACGP
A critical analysis of the books by Dr Leaf:
and

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OUTLINE


Who am I? My name is Dr Christopher Edward Pitt MBBS FRACGP, but I write as Dr C. Edward Pitt to honour my father, Edward Pitt. I am a General Practitioner (or Family Physician in some parts of the world). I work in the booming northern growth corridor of Brisbane, Australia. I have been studying and working in medicine over 20 years.

What is this book about? As the title suggests, it is a reappraisal of the work of Dr Caroline Leaf, a South African communication pathologist now residing in the US. Dr Leaf states she is a cognitive neuroscientist, and is one of the most popular Christian authors in the western world. While Dr Leaf has published many works, my review centres on the two books that encapsulate her core teachings.

When and where: This book is the culmination of sixteen months of research and writing in my spare time (usually in the middle of the night and on weekends, much to my wife’s chagrin). This book is available worldwide via the major eBook distributors and the Internet.

Most importantly, why?
“Why criticise Dr Leaf? She is a global Christian phenomenon, teaching from pulpits around the world, endorsed by some of Christianity’s most famous leaders. Surely there’s nothing to reappraise? Is it even Biblical to publically speak against an anointed leader?”

These are just some of the questions I have been asked by my friends during the last year and a half as I have shared some of my research with them.

These are important questions to answer straight off the bat. I want to start by looking at the difference between critique and criticism. The words sound so much alike, it’s easy to assume they’re the same thing. Actually, they’re poles apart.

Criticism is fault finding on a personal level, “the expression of disapproval of someone or something on the basis of perceived faults or mistakes.” [3] Attacking Dr Leaf’s personal beliefs or intentions would be criticism. A critique, on the other hand, is “a detailed analysis and assessment of something, especially a literary, philosophical, or political theory.” [3] We all need ideas to be critiqued. That is how ideas are tested and knowledge grows. Without critique of scientific theories and findings, we would still be living in mud huts as hunter-
gatherers.

Just because Dr Leaf is a Christian leader does not preclude her from critique. She is a scientist, writing about scientific facts and theories. Her work deserves interrogation and analysis like any other scientific work. There is also a Biblical imperative to question, not just to implicitly accept, what we are taught by Christian leaders. In 2 Peter 2:1-3, Peter notes that there are many false prophets that we need to be wary of. Without critique, how do Christians see both sides of an argument and make up their own minds? And 1 Thessalonians 5:21 says, “test everything; hold on to the good”. How is one supposed to know what is good if no critique is offered, if only one position is provided? Don’t stress, I’m not saying Dr Leaf is a false prophet. But scripture is clear; it’s ok to ask questions, to look at both sides of a discussion, to critique and to be critiqued.

It’s my intention to be as impartial as possible. Some people may interpret what I say as more personal than objective, and if I do slip from critique into criticism, I apologise. But I am still human after all.

The other question that I’m asked is why I even need to critique Dr Leaf’s work at all? She must have her facts straight if she is preaching at some of the biggest churches on the planet, right? To be honest, I started reading her books with the same assumption in mind. But as my first consultant told me, on my very first ward round, on my first day as a doctor, “When you assume, you make an ‘ass’ out of ‘u’ and ‘me’”. Keep an open mind as you read this book. In fact, I encourage you to look at the quotes from Dr Leaf’s work to satisfy yourself that I’m not misquoting her, and check out my references for yourself so that you know I’m not misinterpreting the science. Decide for yourself whether what I’ve said is right or not.

I have written the book in four sections. In the first section, I outline the basics of neurobiology especially as it applies to thought, from the nerve cell all the way through to the complex interplay of neural networks. I define what a thought is, and what are often mistaken for thoughts. I discuss the current scientific theory of the neurobiology of thought – where thought is housed in our brains, and how the neural networks influence it. I also outline some of the key psychological models of thought.

I spend some time in fleshing out a model which I call the Cognitive-Action Pathways model, a generic paradigm of the human neurophysiological information processing system, encompassing the different components that form the basis of our thoughts and actions. I use Autism Spectrum Disorder as an example of how changes in genes, the most fundamental part of the model, flow on to effect every other part of the sequence, influencing every action taken by a person on the autism spectrum.

Within this model, I propose that thoughts aren’t actually integral to the sequence from initial sensory input to the final action, but instead act as a monitor allowing us some conscious awareness of the ongoing neural activity underneath.

This model shows that thought has, at best, a small impact on the rest of the neurocognitive system. This is important for two reasons. Firstly, the underlying problem common to mental health disorders is not thought, but the processes that underlie thought. Therefore, treating the mental health disorders does not involve targeting thought any more than fixing your computer software involves replacing your monitor.

Secondly, the model demonstrates that Dr Leaf’s concept of thought is critically flawed. Thought is a form of output from the system, not the controlling force. Thought in and of itself does not control our lives. Neither can we ever be fully in control of our thoughts, because our thoughts are dependent on a number of other components in the system, most of which we do not have any control over. Nor does thought cause stress. We may be aware of
stress changes within our internal processing systems because of certain patterns of thoughts but those thought patterns are the end result, not the cause.

In section 2, I consider the topic of stress in more detail. I discuss the various concepts of stress, and I demonstrate that stress is not toxic in the majority of circumstances. Indeed, stress is beneficial more times than it is harmful.

In the very short section 3, I bring the first two sections together, comparing what science currently says with Dr Leaf’s fundamental assumptions, highlighting the weakness of Dr Leaf’s foundational concepts.

Section 4 speaks to the numerous errors that Dr Leaf makes in trying to build a case for her assumptions. I show that Dr Leaf’s “evidence” for her assumptions and arguments are archaic, biased, or outright contradictory. I also fact-check Dr Leaf’s chapters on epigenetics and quantum physics, highlighting the factual errors presented and the false conclusions drawn. I review another of Dr Leaf’s long held theories, that the heart is a mini-brain.

The book is long, and can be heavy going at times. If it’s too much to digest all at once, break it up into sections, or use it as a reference to review Dr Leaf’s books, or ongoing posts on social media.

If you still agree with Dr Leaf at the end of the book, that’s fine. The aim of this book isn’t to win an argument, but to be the alternative voice, to collate the scientific evidence that doesn’t necessarily unite with Dr Leaf’s various theories, so that you could more easily decide for yourself. If that’s what I’ve achieved, I’m satisfied.

“Test everything. Hold on to the good.”

CEP, August 2014.

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**PREFACE**

It was a cold night in July 2013. I took up my position at my computer at the end of the day to do something important, and as usual, I wound up flicking through Facebook instead. A link to a Time article caught my attention.

“Rick Warren Preaches First Sermon Since His Son’s Suicide.
Almost four months after their son committed suicide, Pastor Rick Warren and his wife Kay addressed their congregation for the first time, promising to remove the stigma of mental illness from the church.”

Reading the article moved me immensely. It took me quite a long time to finish the article, as the flood of emotions was overwhelming, and the stream of tears made it difficult to read the words.

I was moved by Rick Warren’s remarkable courage and vulnerability. I was also moved by his openness in confronting depression, a phenomenon that is overwhelming our culture despite our best attempts to ignore or suppress it.

Depression remains largely hidden by our outward displays of invincibility or perfection. No one wants to see our pain, our tears or our weakness, and wearing our mask of social acceptability helps us to hide them. But while we try and keep depression out of sight, it doesn’t make it out of mind. It is widely prevalent among us. For every seven people that you see around you, one of them will experience clinical depression in their lifetime. Six percent of people are clinically depressed at this moment. Considering the numbers, you
would think that people would have learnt to deal with depression in an understanding and sensible way. But still, people without depression think people with depression are weak, malingering, or mentally unstable.

It’s these sorts of assumptions, or just plain old ignorance, that keep people from identifying their depression, from seeking help when they know that something is wrong, or from accepting treatment when they’re given a diagnosis. It’s the voice of their friends or family in their heads telling them that they’re ok. Just have a laugh or have a drink, you’ll be fine. It’s remembering how their co-workers vilified that girl in the office when she said she was depressed, and not wanting the same treatment. It’s the shame and self-condemnation of not being able to cope. It’s the internal conflict of having everything, and yet feeling like you have nothing.

Depression is a dark, lonely and tormenting place. I know, because I suffer from it. In the two years that I was at my lowest, I was moody. I was emotional. I exploded in anger or melted in tears. I was sullen. I hardly ever laughed, because I didn’t find anything funny. It felt like my soul had been drained from me.

I couldn’t face anyone socially. I am not a socialite at the best of times, but the thought of having to go out to engage with friends and family was draining, sometimes physically distressing. When I was dragged out, I was withdrawn.

This is where the stigma of depression, and depression itself, feed into each other. I was so depressed that I didn’t want to interact with people, and when I did, I was sullen and withdrawn. This was not interpreted as depression by other people, but as arrogance. Besides, even if they knew I was depressed, it’s not exactly an endearing quality. Who would want to hang around with someone who had the charm and charisma of a dead fish?

The complete absence of joy and pleasure in anything was difficult enough. But the existential angst was even more tormenting. I questioned my salvation. I questioned God’s love. I was plagued by the fear that I would die a lonely useless failure, unloved and unlovable. I occasionally questioned the existence of God himself.

I knew what the Bible said, and if anything, that haunted me more. I couldn’t understand why I could love God, serve Him and live for Him, and still not have any joy. God is perfect, so the obvious conclusion was that it was my fault that I was feeling this way. It must have been my sin, my selfishness, my … something! The self-loathing that resulted from this way of thinking compounded my already poor mood and made me feel even worse than I already was.

Ironically, all of this was aggravated by church. Incessantly chirpy people with permanent beaming smiles were everywhere. In a typical large church, you can be peppered by the standard church greeting up to twenty times before you even reach your seat. It always follows the same pattern: “Hey! How are you today? Isn’t it a great day to be in church? Isn’t God good? Isn’t it wonderful to be alive?”

Despite being rhetorical questions, they still reminded me just how awful I felt. I toyed with the idea of replying truthfully, but answering, “Oh, I’m just having an existential crisis” would have ended in explaining myself to some well-meaning but ill-equipped wannabe counsellor, or being assessed as a dysfunctional twerp. So I just kept suppressing my pain and lied, “Oh, I’m just a bit tired … you know … work …”.

Thoughts of “It would be so much easier if I wasn’t here” came to me at different times. I never seriously contemplated suicide, but I understand why people do. Depression deprives you of hope. I was literally hope-less. Paul wrote that there abides three things - faith, hope
and love. I had none of them.

During all of this time I kept working. I didn’t go to work because I gained any satisfaction from it. I went more out of mindless habit. I could smile for patients, carry on a pithy conversation, and even counsel people about their own depression, all the while hiding my own.

The first meaningful step in my recovery came when I went to see a psychologist. I don’t actually remember what we talked about specifically, although I do remember going through most of the tissues he had in his office as I unloaded years of emotional turmoil and despair with someone who accepted me without judgment or disdain.

I also came to understand “the wilderness”. I was depressed, but I was in good company. Moses, David and Elijah spent time in the physical wilderness, and each of them went through periods of mental destitution as well as physical deprivation. But I identify with Peter most of all.

Peter was with Jesus, the Messiah himself, everyday for nearly three years. He heard all of Jesus’ words, he saw the miracles and even witnessed the transfiguration of Jesus where the physical and spiritual realms blended together in magnificent glory. He must have felt the surge of the Holy Spirit’s power as he watched Jesus teach, heal, and love the people that swarmed him. Such a privileged place in history must have made the pain of his crash all the more intense. Peter must have experienced some of the deepest loss, most abject sense of failure and most profound alienation that any human could feel when he rejected the Messiah, his friend. Even seeing the empty tomb on Resurrection Sunday couldn’t overcome his sense of despair and worthlessness. He drifted back to his old life of fishing, giving up on life with God completely.

I found hope in Peter’s restoration. Jesus went to Peter and found him desolate and frustrated, toiling all night with absolutely nothing to show for it. Jesus not only gave Peter the biggest catch of fish in his life, but showed him such a profound depth of understanding and kindness over breakfast on the shore. Peter may have abandoned Jesus, but Jesus never abandoned Peter. If Jesus still loved Peter in spite of all his flaws, then surely Jesus still loved me.

I have come out the other side of my depression now, with a much deeper, fuller appreciation of what it is to be human. The textbook description of depression that I was familiar with was nothing compared with actually experiencing it. When I talk to people with depression now, I can wholeheartedly empathize.

Rick Warren talked about the stigma of mental health. I can sincerely relate with this as well. It’s hard enough for non-Christians to admit they’re depressed, but there’s an extra layer of misunderstanding when it comes to the church, especially the charismatic churches. It’s a passion, perhaps even my calling, to help bridge the gap. People with depression, and indeed, all those who suffer any form of mental distress, need to be understood and accepted without judgement, not written off as weak or worthless.

Dr Leaf has been writing about toxic thoughts since the mid-1990s. Just as Dr Leaf was formulating her theory of toxic thoughts based on the dominant psychological model of the time, a new wave of understanding our thoughts and actions was gathering momentum. In the last twenty years, the “third wave” of cognitive and behavioural therapies, specifically a therapy called ACT, has overtaken the previous concept of thought. But while the rest of the world has begun to adopt a new way of understanding the relationships of thought and behaviour, Dr Leaf has remained steadfastly attached to the old model.

It’s important that Dr Leaf is acknowledged for the good she has brought to the church. Dr
Leaf has brought awareness of psychological issues to the Christian church, and there’s no doubt that Dr Leaf’s writing and teaching have helped some people through difficult situations.

But health and life relies on renewal. Our skin cells, our blood, our muscles, even the synapses between our brain cells, are all constantly replenished – old is replaced by new. Science is the same, each new level of knowledge building upon the old. Unfortunately, Dr Leaf has not kept up. Dr Leaf’s theories may have had a place in the past but they have now been superseded. Dr Leaf has forced new facts to fit her old theory, rather than develop her theory to fit the facts.

The Bible says it’s like new wine in old wineskins. In everyday life, it’s like trying on your old skinny jeans from ten years ago. You may think they still fit, but your new body doesn’t quite match your old shape, and even if you get those pants on after struggling for half an hour, they’re tight, restrictive, and just plain uncomfortable. New information may seem like it still fits into the old theories, but like those skinny jeans, forcing new into old is difficult, restrictive and uncomfortable. New information needs new theories to hold them best.

So that’s what this book is about – fitting the growing body of scientific evidence on thought and stress into concepts that fit best, and displaying them for everyone to see. In doing so, I hope that the mental health knowledge gap would continue to shrink, and that one day in the not-to-distant future, pastors like Rick Warren won’t have to stand in front of their congregations and promise to remove the stigma of mental health from the church, because it will have already gone.

POST-SCRIPT

Just as I was about to publish the book on-line, I heard the tragic news of the death of Robin Williams. The world has lost a truly remarkable man. I saw him perform live only the once. Such was the piercing sharpness and rapidity of his humour that my mind couldn’t keep up, but he enlivened my soul in a raw, pre-cognitive way that I’ve never experienced, before nor since.

Williams was a man conflicted in the most ironic of ways - one of the funniest people to ever grace the earth, at the same time, tormented by the depths of despair and darkness. It was like his soul was a pair of theatre masks.

If there’s any good that can come from in this profound loss, I hope it’s this: That we understand that depression is serious, it kills people if not properly treated, and sometimes all the positive emotion in the world is not enough to pull you out of the darkness.

If you’re feeling depressed, anxious, morbid, low or distressed, make sure you get the best help you can get from your doctor or psychologist.

~ Vale Robin Williams, 21/7/1951 ~ 11/8/2014. You will be truly missed ~

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SECTION 1

THOUGHT, AND THE COGNITIVE-ACTION PATHWAYS MODEL

CHAPTER 1 - THOUGHT

Think you know what thought is? It may not be as simple as you think!
We’re all familiar with thought, to be sure, just like we’re familiar with our own bodies. But just because we know our own bodies doesn’t make us all doctors. In the same way, we might know our own thoughts well, but that doesn’t make us experts in the science of thought. So that we all start on the same page, we start with a cook’s tour of neurobiology and psychology, setting the scene to define what thought really is, according to current models of cognition and volition.

Are you ready? Let’s go on a journey.

**NEUROBIOLOGY 101**

**The nerve cell**

At the most fundamental level of our thought process is the nerve cell, also called a neuron. Nerve cells, like all cells in the body, have a nucleus containing the genetic material. The nucleus is surrounded by cytoplasm, a watery chemical soup that contains the functional proteins that make the cell run. A thin lipid layer called the cell membrane envelopes the nucleus and cytoplasm. The cell membrane contains important protein structures such as receptors that help the cell receive signals from other cells, and ion channels, which help the cell regulate its internal chemistry.

Compared to other cells, nerve cells have three unique structures that help them do their job. First are dendrites, which are spiny branches that protrude from the main cell body, which receive the signals from other nerve cells. Leading away from the cell body is a long thin tube called an axon which helps carry electrical signal from the dendrites, down to the some tentacle-like processes that end in little pods. These pods, called the terminal buttons of the axon, and then convey the electrical signal to another nerve cell by directing a burst of chemicals towards the dendrites of the next nerve cell in the chain.

In order for the signal to be successfully passed from the first nerve cell to the second, it must successfully traverse a small space called the synapse.

**The synapse**

Despite being very close to each other, no nerve cell touches another. Instead, the spray of chemicals that’s released from the terminal button of the axon floats across a space of about 20-40nm (a nanometre is one billionth of a metre).

There are a number of different chemicals that traverse synapses, but each terminal button has its own particular one. The most well known are serotonin, noradrenaline and dopamine.

If the signal from the first nerve is strong enough, then a critical amount of the chemical is released and will make it across the gap to the dendrites of the second nerve cell on the other side. The chemical interacts with specific receptors on the new dendrites, which cause them to open up to certain salts like sodium and potassium. As sodium and potassium move in and out of the cell, a new electrical current if formed in the second nerve cell, passing the signal down the line.

To prevent the chemicals in the synapse from over-stimulating the second nerve cell, enzymes breakdown the chemicals to clear the space before the next signal comes past.

**Nerve pathways**

Combining nerve cells and synapses together creates a nerve pathway, where the input signal is received by specialised nerve endings and is transmitted down the nerve cell across a synapse to the next nerve cell, across the next synapse to the next nerve cell, and on and on until the signal has reached the destination for the output of that signal.
And that’s it. The entire nervous system is just a combination of nerve cells and the synapses between them.

What gives the nervous system and brain the near-infinite flexibility, and air of mystery, is that there are eighty-six billion nerve cells in the average adult (male) brain. Each nerve cell has hundreds to thousands of synapses. It’s estimated that there are about 0.15 quadrillion (that’s 150,000,000,000,000) synapses throughout the average brain [4]. And that’s not including the nerve cells and synapses in the spinal cord, autonomic nervous system and throughout the body. Each of these cells and synapses connect in multiple directions and levels, and transmit signals through the sum of the exciting or inhibiting influences they receive from, and pass on to, other nerve cells.

Single nerve cells may have the appearances of trees with their axon trunks and dendritic branches. But altogether, the billions of connections would more resemble a box of cobwebs.

Higher order brain structures

But unlike a box of cobwebs, the brain has precise organisation to the myriad of connections. These areas can be defined either by their structure, or by their function.

Structurally, there are areas in the brain that are dominated by nerve cell bodies, formed into a little cluster, called a nucleus (different from the nucleus of each cell). Then there are groups of axons bundled together, called a tract, which behave like a data cable for your computer. Nuclei process multiple sources of signal and refine them. The refined signals are sent into the appropriate tract to be transmitted to either another set of nuclei for further refinement, or to distant structures to carry out their effect. The axons of the nerve cells that make up the tracts are usually covered in a thick white material called myelin. Myelin acts like insulation on a wire, improving the speed and accuracy of the communicated signal. Parts of the brains with lots of myelinated cells are described as “white matter”. The nuclei and the cerebral cortex (the outer covering of the brain) are unmyelinated cells, and are referred to as “grey matter”.

On a functional level, the brain is divided into parts depending on what information is processed, and how it gets processed. For example, the cerebral cortex is divided into primary areas for the senses and for motor functions, secondary areas and tertiary association areas. The primary sensory areas detect specific sensations, whereas the secondary areas make sense out of the signals in the primary areas. Association areas receive and analyze signals simultaneously from multiple regions of both the motor and sensory areas, as well as from the deeper parts of the brain [5]. The frontal lobe, and specifically pre-frontal cortex, is responsible for higher brain functions such as working memory, planning, decision making, executive attention and inhibitory control [6].

Everything our senses detect is essentially deconstructed, processed then reconstructed by our brains. For example, when reading this page, the image is decoded by our retina and sent through a number of pathways to finally reach the primary visual cortex at the back of our brain. The primary visual cortex has 6 layers of nerve cells which simultaneously encode the various aspects of the image (especially colour, intensity and movement of the signals) and this information is sent to the secondary association areas that detect patterns, both basic (lines are straight, curved, angled) and complex (two diagonal intersecting lines form an ‘x’). One part of the secondary association areas in the visual cortex (the Angular Gyrus) processes these patterns further into the patterns of written words. The information on the various patterns that were discerned by the secondary association areas then get sent to the tertiary association area for the senses where those visual patterns are combined with patterns processed from other sensory areas (hearing, touch and internal body sensations) to form a
complex pattern of multimodal association [5]. In the case of reading, the tertiary association area allows comprehension of the written words that were previously only recognised as words by the secondary association areas.

In the recent decades, with the widespread adoption of non-invasive methods of studying the active living brain such as PET scanning and fMRI, researchers have discovered that rather than discrete parts of the brain lighting up with a specific task, entire networks involving multiple brain regions are activated. This has lead to the paradigm of neurocognitive networks, in which the brain is made up of multiple interconnected networks that “are dynamic entities that exist and evolve on multiple temporal as well as spatial scales” and “by virtue of both their anatomical and functional architectures, as well as the dynamics manifested through these architectures, large-scale network function underlies all cognitive ability.” [7]

**Emotions and feelings**

Emotions are a difficult concept to define. Despite being studied as a concept for more than a century, the definition of what constitutes an emotion remains elusive. Some academics and researchers believe that the term is so ambiguous that it’s useless to science and should be discarded [8].

I’ll discuss emotions further in chapter 2, but for now, it’s easiest to think of our emotional state as the sum total of our different physiological systems, and feelings are the awareness, or the perception of our emotional state.

Different parts of the brain are responsible for the awareness of these feelings. The amygdala is often considered the seat of our fears, the anterior insula is responsible for the feeling of disgust, and the orbitofrontal and anterior cingulate cortex are involved in a broad range of different emotions [9].

Different emotional states are linked with different neurotransmitters within the brain. For example, a predisposition to anxiety is often linked to variations in the genes for serotonin transport [10] while positive and negative affect (“joy / sadness”) are linked to the dopaminergic system [11].

**Memories**

Memories, like thoughts, are something that we’re all familiar with in our own way.

Memory is quite complicated. For a start, there’s more than one form of memory. You’ve probably heard of short term and long term memory. Short term memory is further thought of as sensory memory and working memory. Long term memory is divided into semantic and episodic memory. Memory is also classified as either declarative memory, also called explicit memory, and nondeclarative memory, also called implicit memory.

Squire and Wixted explain, “Nondeclarative memory is neither true nor false. It is dispositional and is expressed through performance rather than recollection. These forms of memory provide for myriad unconscious ways of responding to the world. In no small part, by virtue of the unconscious status of the nondeclarative forms of memory, they create some of the mystery of human experience. Here arise the dispositions, habits, and preferences that are inaccessible to conscious recollection but that nevertheless are shaped by past events, influence our behavior and mental life, and are an important part of who we are.” [12]

On the other hand, declarative memory “is the kind of memory that is referred to when the term memory is used in everyday language. Declarative memory allows remembered material to be compared and contrasted. The stored representations are flexible, accessible to
awareness, and can guide performance in a variety of contexts. Declarative memory is representational. It provides a way of modeling the external world, and it is either true or false.” [12]

Working memory is a central part of the memory model. Information from feelings, stored memories and actions all converge in working memory. The model of working memory initially proposed by Baddeley involves a central executive, “a control system of limited attentional capacity that is responsible for the manipulation of information within working memory and for controlling two subsidiary storage systems: a phonological loop and a visuospatial sketchpad.” [13] Baddeley later added a third subsidiary system, the episodic buffer, “a limited capacity store that is capable of multi-dimensional coding, and that allows the binding of information to create integrated episodes.” [13]

Working memory is known to be distinct from other longer term memories that are dependent on part of the brain called the hippocampus, because patients with severe damage to the hippocampus can remember a small amount of information for a short time, but are not able to push that information into longer term memory functions to retain that information. Information in working memory doesn’t last for any more than a few minutes [12].

So, there are many forms of memory that are important to our lives and influence our behaviour that are “inaccessible to conscious recollection”. But even declarative memory, which is accessible to thought, doesn’t actually make up the thought itself. Memories are stored representations.

When memories are formed or retrieved, the information is processed in chunks. As Byrne pointed out, “We like to think that memory is similar to taking a photograph and placing that photograph into a filing cabinet drawer to be withdrawn later (recalled) as the ‘memory’ exactly the way it was placed there originally (stored). But memory is more like taking a picture and tearing it up into small pieces and putting the pieces in different drawers. The memory is then recalled by reconstructing the memory from the individual fragments of the memory.” [14] Recalling the original memory is an inaccurate process, because sometimes these pieces of the memory are lost, faded or mixed up with another [15]. This is why what we perceive and what we recall are often two different things entirely.

Why do we have memory then, if it’s so flawed at recalling information? Because memory is less about recalling the past, and more about imagining and planning the future. As Schacter writes, “The constructive episodic simulation hypothesis states that a critical function of a constructive memory system is to make information available in a flexible manner for simulation of future events. Specifically, the hypothesis holds that past and future events draw on similar information and rely on similar underlying processes, and that the episodic memory system supports the construction of future events by extracting and recombining stored information into a simulation of a novel event. While this adaptive function allows past information to be used flexibly when simulating alternative future scenarios, the flexibility of memory may also result in vulnerability to imagination-induced memory errors, where imaginary events are confused with actual events.” [16]

**NEUROSCIENCE OF THOUGHT**

**Global Workspace / Intelligent Distribution Agent Model**

Building on Baddeley’s model of working memory, Baars proposed the Global Workspace theory [17], and went further by adding the Intelligent Distribution Agent model [18]. Central to this model is the “Cognitive cycle”, a nine-step description of the underlying process from perception through to action. In the model, implicit neural information processing is considered to be a continuing stream of cognitive cycles, overlapping so they act
in parallel. The conscious broadcast of our thought stream is limited to a single cognitive cycle at any given instant, so while these thought cycles run in parallel, our awareness of them is in the serial, sometimes disparate, streams of words or pictures in our minds. Baars suggests that as many as twenty cycles could be running per second, and since working-memory tasks occur on the order of seconds, several cognitive cycles may be needed for any given working memory task, especially if it has conscious components such as mental rehearsal [18].

In recent years, the Global Workspace/Intelligent Distribution Agent hypothesis has been updated to help facilitate the quest to create different forms of artificial intelligence. The LIDA (“Learning Intelligent Distribution Agent”) model incorporates the Global Workspace theory with the concepts of memory formation to create a single, broad, systems-level model of the mind.

Franklin et al summarise the process, “During each cognitive cycle the LIDA agent first makes sense of its current situation as best as it can by updating its representation of its current situation, both external and internal. By a competitive process, as specified by Global Workspace Theory, it then decides what portion of the represented situation is the most salient, the most in need of attention. Broadcasting this portion, the current contents of consciousness, enables the agent to chose an appropriate action and execute it, completing the cycle.” [19] Information within the cognitive cycle is broadcast to our consciousness in order to recruit a wider area of the brain to enhance the processing of that information [18, 20]. It’s the broadcasting of this portion of the information flow that renders it “conscious”. Thought, therefore, is simply a broadcast of one part of a deeper flow of information. This is very important, as it means that thought is not an instigator or a controlling force. It’s not a case of, “I think, therefore, I am”, but, “I am, therefore, I think.”

**Neural networks involved in the neurobiology of thought?**

There is good evidence that working memory, and the attention required to select the information streams that fill the global workspace at any one moment, are intrinsically linked to a group of brain regions tagged as the Prefrontal Parietal Network [21]. Disease or damage to the PPN or impairment of the PPN in the lab impairs normal conscious function. Research-level brain imaging studies have strongly implicated the PPN in perceptual transitions, the conscious detection of stimuli in a range of modalities, sustaining percepts, and in metacognitive decisions (awareness of awareness) on those percepts. Finally, a reduction of conscious level when under general anesthesia is associated with a reduced lateral prefrontal activity [21].

Other neural networks have been defined that are also important in the neurophysiology of conscious awareness. When there are no external stimuli, the brain doesn’t just turn off. Some parts of the brain become even more active. The same parts of the brain are active when we daydream (what researchers call “stimulus independent thought”).

We have all experienced this at some point. Our body will be doing something while our brain is off somewhere else. I find this happens to me when I’m driving home from work. Going the same route every day means that I often drift into autopilot as I’m thinking about the events of the day or my stomach reminds me that I’m hungry, and five minutes later I pay attention to my surroundings and realise that I’m nearly home.

There are many other sentinel neurocognitive networks, among them: the default mode network, the central executive network, and the salience network. The central executive network is involved in actively working on an external task, which we think of as attention. The default mode network is involved in autobiographical retrieval and self-monitoring
activity, the “stimulus independent thought”, or day-dreaming. The salience network acts as a switch between the two, figuring out which external stimuli need active attention and switching on the central executive network [7]. Whichever one of these networks is active at the time, that network is actively feeding information into the working memory, which is what we perceive as “thought”.

When the brain is engaged in a new or difficult task requiring active attention, the executive parts of the brain overtake the default mode network. But when attention is not actively required such as well-practiced tasks, or if our attention diminishes as with boring tasks, the Default Mode Network becomes dominant again. The switch between attention and the default mode network is strongly related to the neurotransmitter dopamine [22]. These networks heavily overlap with the Prefrontal Parietal Network and the global workspace model.

Recent neurobiological evidence confirms the role the default mode network in thought processing, specifically the part of the brain called the cingulate cortex. This has been confirmed in studies in healthy subjects [23], and in people with formal thought disorders (especially auditory verbal hallucinations) [24]. Specifically, the DMN is often the part of the brain that is the most active in remembering the past, and using similar mechanisms, also the simulations of the future. It is linked to daydreaming and creativity especially when a problem is allowed to “incubate” for a while, while the brain is involved in another task that is more menial, or low stress. It’s theorised that the attentional and implicit networks in the brain are brought into a closer proximity and allowed to interact, which improved the likelihood that a novel solution would be discovered [25].

Research into the topics of thought and consciousness is ever-growing and expanding, and if you want to read more about these topic, they have been very well covered in a two part series from De Sousa, [26] and [27].

OTHER COGNITIVE FRAMEWORKS OF THOUGHT

Dual Systems Model

As I briefly touched on before, the Dual Systems model of human reasoning explains our cognitive process in terms of two systems.

System 1 involves a set of different subsystems that operate in parallel, delivering swift and intuitive judgments and decisions in response to our perceptions. System 1 is unconscious, automatic and guided by principles that are, to a significant extent, innately fixed and universal among humans.

System 2 is the system that involves “thought” as people typically think about it. It is both conscious and reflective in character, and proceeds in a slow, serial manner, according to principles that vary among both individuals and cultures [28]. This system is in harmony with the Global Workspace concept of the cognitive cycle.

System 2 is generally held to be subject to intentional control, hence why thoughts can be volitional. System 2 can be guided by normative beliefs about proper reasoning methods. In other words, we can learn ways of thinking about our thoughts to handle them better. And one of the principal roles often attributed to system 2 is to override the unreflective responses that are issued automatically by system 1 in reasoning tasks, when these fall short of appropriate standards of rationality. We can use thought to modulate or suppress our intuitive responses, the concept of “think before you act”.

Neural networks which function as described by the Dual Systems model have been confirmed by research, and have taken the theory further [9]. Not only can stimuli that are
emotionally significant activate the lower, emotional parts of our brain, they can do so without us ever being consciously aware they were detected. For example, when test subjects had their visual cortex temporarily stunned by a transcranial magnetic stimulator, they could detect whether a face was happy or sad and even where it was on a grid without consciously sensing that they had “seen” a face [29]. Subconscious emotional stimuli can modulate our attention before we are aware of their perception [30].

**Relational Frame Theory / Acceptance And Commitment Therapy**

Relational frame theory, and the clinical approach based on it called Acceptance and Commitment Therapy, sees thoughts as contextual. This is interesting, as new neurobiological approaches such as neurocognitive networks are also girded by the developing view of cognition which is that cognition “is marked by both dynamic flexibility and context sensitivity.” [7]

Relational frame theory posits that “the core of human language and cognition is learning to relate events mutually and in combination not simply on the basis of their formal properties (e.g., size, shape) but also on the basis of arbitrary cues.” [31] Basically, we understand things in both concrete and abstract ways. “The gold coin is small” is referring to the tangible properties of the gold coin. “The gold coin is very valuable” is referring to the arbitrary properties of the gold coin, which are values that we define in our minds.

Hayes states, “A key RFT insight of clinical importance is that relational framing is regulated by two distinguishable features: the relational context and the functional context ... The relational context determines what you think; the functional context determines the psychological impact of what you think.” [31]

So in terms of thought, what we think isn’t necessarily reliable. It’s contextual, and often abstract and arbitrary. The meanings and values that are placed on our thoughts are related to the context in which they came to us, and the impact is also arbitrary, a function of our minds and our language.

As William Shakespeare wrote, “for there is nothing either good or bad, but thinking makes it so.” [32] Thoughts are just that - thoughts. So while there is a mountain of published literature on “negative” or “positive” thoughts, such distinctions are subjective, arbitrary, and often entirely unhelpful.

We often become fused to the meaning of our thoughts. We begin to take them literally, without noticing the process of thinking itself. When the thoughts become painful, we don’t know how to handle them, and we run from them, or try to suppress them. But in fighting with the thoughts, we actually draw attention to them and make them more powerful. This makes them even more painful, and makes the avoidance worse. We then lose flexible contact with the present moment, as we become more and more consumed with the internal battle with our painful thoughts and subsequent emotions. Rather than looking around us, all we can do is focus on the pain or be anywhere else where difficult events are not occurring. [31]

The key in this battle is not to engage with the “negative” thoughts by pushing them away or trying to change them. Pushing the painful thoughts away makes them go away for a while, but it takes a lot of effort. The thoughts return as we tire, but we have less energy to resist them.

Try holding a fully inflated basketball under water. It’s possible, but the basketball wants to get back to the surface. Holding it down is hard work. You usually can’t do it for long. Fighting our thoughts is the same.
Harris describes the focus of Acceptance and Commitment Therapy, “around two main processes: developing acceptance of unwanted private experiences which are out of personal control, commitment and action towards living a valued life … In ACT, there is no attempt to try to reduce, change, avoid, suppress, or control these private experiences. Instead, clients learn to reduce the impact and influence of unwanted thoughts and feelings, through the effective use of mindfulness.” [33]

The first principle of ACT is to start treating thoughts as what they really are … just thoughts. This is simply done by learning to observe the process of thinking again, to realise that the words going through our minds are just words. They only have the meaning that we give to them. They only have the power that we allow them to have.

We will discuss this later on in this section, but the key to overcoming thought patterns we don’t want isn’t to change them, it’s to remove their power. Trying to change them means engaging with them, which only makes them stronger. Disempowering them means seeing them for what they are. They may sound like Rottweiler’s but when you actually look, they’re more like Chihuahua’s with megaphones. When you understand that your thoughts are not in control, you can move forward into the actions that really bring change.

WHAT IS, AND IS NOT, A THOUGHT?

Thought, therefore, is simply a broadcast of one part of a deeper flow of information. Thought is not a controlling force. It’s not a case of, “I think, therefore, I am”, but, “I am, therefore, I think.”

Thoughts are often described in the peer-reviewed publications as the “stream of thought” or the “stream of consciousness”. According to Baars, thoughts arise from the broadcast step of multiple cognitive cycles, but the conscious broadcast of our thought stream is limited to a single cognitive cycle at any given instant. Thus, even though it is considered a “stream”, our awareness of our thought is in a serial, sometimes disparate, sequence of frames.

There are some features of our stream of thought that differentiate it from other brain activity. We have a level of voluntary control over our stream of thought, even if it’s not direct [15]. It is also characterized by a metacognitive level – we have “thinking about thinking” [28, 34], and we have “awareness of awareness” [35].

Yet there are still many neurological functions that are confused with thoughts.

Brain activity

“Thoughts” are often confused for any brain activity. The stream of thought is sometimes referred to as the “stream of consciousness” but that’s a misnomer.

Consciousness has varying levels (coma, deep sleep, lucid dreaming, awake, and alert). Only some of these levels of consciousness allow thought. Therefore, it would be fair to say that thoughts are a form of activity of the brain, just like Toyotas are a form of car.

Brain activity is largely subconscious. It carries on in the background without our awareness [9]. There are multiple simultaneous streams of data being perceived all the time - sensation from our ears, skin, eyes and internal organs - that our brain filters out before it reaches our awareness. Background traffic noise, the pressure of your clothes on your skin, joint position, heart rate and breathing, for example. It’s not that these sensations are not present, but you only become aware of them when your attention is drawn to them. Those data streams are not thoughts in and of themselves because we lack awareness of them. They only become part of our thoughts when attention is paid to them. Since thoughts are characterized by metacognition, “awareness of awareness”, then neural activity we aren’t aware of cannot be
considered thoughts.

The other problem with defining all brain activity as “thought” is that such as definition would also mean that seizures were thoughts, or brainstem reflexes were thoughts. We intuitively know that’s not the case.

Dreams

So what about dreams? We’re aware of dreams, aren’t we? Could dreams be considered thoughts?

Dreams are awareness of perception and emotion, similar to our state of awareness when we’re awake. But dreams occur in an altered state of consciousness (that is, we are asleep). Dreams also lack self-awareness. When you dream, you don’t realise that you’re dreaming. Secondary consciousness, the level of consciousness that we possess when we are awake, is defined in part as having awareness of awareness. It is more than just having awareness of perception and emotion. It is “self-reflection, insight, judgment or abstract thought that constitute secondary consciousness.” [35]

Memories

As I wrote earlier, memories aren’t just simple recall, but a complex system involving both conscious and unconscious elements. The conscious elements of memory are simply stored representations of events and experiences. They may become part of a thought broadcast, but they are not thoughts per se.

“THINKING” AND “CHOOSING”

Human volition is a very broad topic in its own right. Choice has been philosophically dissected for centuries. Haggard observed, “Most adult humans have a strong feeling of voluntary control over their actions, and of acting ‘as they choose’. The capacity for voluntary action is so fundamental to our existence that social constraints on it, such as imprisonment and prohibition of certain actions, are carefully justified and heavily regulated.” [36]

Volition and action are the output side of a broad continuum of neurological function. The executive areas of our brain, including the default mode network, interact with parts of our brain whose functions involve the planning and coordination of movement, specifically the basal ganglia and the pre-supplemental motor area. The vast majority of neurological activity that occurs during the planning and execution of an action occurs unconsciously [15, 37]. We aren’t aware of every action involved in walking into a room, or sipping coffee from our cup. To consciously control every aspect of every action would be impossible.

Indeed, in the same way that thought is simply a broadcast of a small part of a much larger neurological process, so it is that conscious voluntary control is a broadcast of part of a much larger process of goal, reward, and action comparisons going on underneath our awareness. Research shows that subliminal priming significantly influences cognitive control [37]. Some researchers in this area believe that this projection of information into our awareness provides an element of real-time monitoring and an inhibitory, or veto function [15]. However it may be that it provides recruitment of additional areas of the brain to assist in the processing of the various possible actions and their rewards functions, similar to the function of the broadcast within the cognitive cycle [18, 20].

Either way, cognitive neuroscience has proven that thought does not drive our conscious volition. Over three decades ago, Libet performed an experiment that demonstrated measurable neural activity occurring up to a full second before a test subject was consciously aware of the intention to act [38]. More recently, a study by Soon et al showed that
predictable brain activity occurred up to eight seconds before a person was aware of their intention to act [39]. As Bonn says, “the gist of these findings is that our feeling of having consciously willed an act is illusory in many ways. It seems that the conscious awareness of intention that we place so much weight upon, that we naively think of as causal, is, in fact, a narrative construction that is formed well after the train of causation has been set in motion.” [15]

Haggard concludes, “Modern neuroscience rejects the traditional dualist view of volition as a causal chain from the conscious mind or ‘soul’ to the brain and body. Rather, volition involves brain networks making a series of complex, open decisions between alternative actions.” [36]

This does not eliminate our capacity to choose, but frames it in a more realistic fashion. As Bonn points out, “Although we are not consciously aware of what is going on at every stage of the chain of neural events leading to action, there is room for a degree of conscious involvement if only to pull the emergency brake before it is too late. Thus, although it may not be the initial source of motivations and behavioral impulses, the part of the mind that is self-reflective; that can envision the self in causal and narrative contexts, may serve important monitoring and control functions.” [15]

Bonn concluded his discussion on the modern concept of free will, “… if one accepts that free will can exist in degrees limited by a person’s knowledge and experiences; and, that decisions do not need to be entirely conscious in order to be owned by the individual. Then, I believe there is evidence to posit a level of will and independence within the person.”

So it’s wrong to think of our will being entirely conscious and thought driven. It’s more accurate to say that we still have capacity to choose, but that our will is constrained by our experience and knowledge. Therefore we can make choices, or “exercise our will”, if you like, but within the constraints of a number of factors beyond our conscious control.

We do not have free will – more like constrained will.

**SUMMARY**

Rene Descartes, the French philosopher in the 1600’s, first proposed the famous words, “I think, therefore, I am.” But according to modern neuroscience, Descartes was wrong.

Thought is built on the complex pathways of billions of nerve cells and their synapses, creating quadrillions of possible pathways. Together, these pathways form specialized areas of function in the brain, which network to process the signals coming in, and coordinate the actions going out. Thought is used by the brain to engage larger areas of cerebral cortex in the processing of the salient features of the ongoing, unconscious data stream. Cognitive neuroscience has rejected the philosophical concept of Dualism - thought does not control the underlying data stream, nor does thought control every choice we make or action we take.

According to modern neuroscience, Descartes should have said, “I am, therefore, I think.”

In the next chapter, I will outline a model of the pathways that connect our thought and our action, and show how small changes at the very beginning of the pathway can affect our thoughts and our actions.

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**CHAPTER 2 - THE COGNITIVE-ACTION PATHWAYS MODEL**

Models. From the "really, really ridiculously good looking", to the little ones of cars and
planes that I was never able to build, there are lots of models in the world.

A model in science is not quite as interesting as Zoolander, and definitely not ridiculously good looking, but they are a lot smarter. A scientific model simplifies a complex process to assist with understanding and making predictions.

In the last chapter I described the current concept of thought, based on evidence from modern neuroscience: Our thoughts are a conscious broadcast of a small segments of the much larger cycle of information processing going on in our subconscious brain. But what makes up that larger cycle of information processing? What are the different components that influence the flashes of light on the dark recesses of our brain?

The Cognitive-Action Pathways model combines a number of different cognitive models and other biological influences, into a schematic conceptual representation of the pathways that feed our thoughts and actions.

Using this model, I want to demonstrate how small changes in the processes underlying our thinking can radically change the way people perceive and interact with the world around them, and explain why understanding this knowledge doesn’t take our power to change away from us, but empowers us to make real changes.

THE TIP OF THE ICEBERG

We’ve all heard the phrase, “It’s just the tip of the iceberg.” It comes from the fact that icebergs are made of fresh water, which is nine-tenths less dense than seawater. As a result, ten percent of an iceberg sits above the waters surface with most of it hiding beneath.

The information processing of our brains is much the same. We may be aware of our conscious stream of thought, but there is a lot going on under the surface that makes our
thoughts what they are, even though we can’t see the process underneath.

What’s going on under the surface is a complex interplay of our genes and their expression which controls the structure and function of our brains, which effects how we perceive information, how we process that information and combine it into our memories of the past, predictions of the future, and even the further perception of the present [40].

THE COGNITIVE-ACTION PATHWAYS MODEL

The CAP model describes the process leading to our thoughts and our behaviours. It is formed by a number of loops, or 'pathways', that lead to our cognition and our action.

In formulating the CAP model, I incorporated some well-known and accepted models of cognition, including the Dual Systems Model, and the Cognitive Cycle as described in the Global Workspace/IPA model. I also incorporated concepts not described in other cognitive models, namely the triad of genes, epigenetics and the environment, and the filters of perception and personality*.

THE CAP MODEL - EXPLAINED

Genes, epigenetics and the environment

We start with the most fundamental level of our biological system, which is genetics. It becomes clear from looking at any textbook of biological sciences that genes are fundamental to who we are. From the simplest bacteria, fungi, protozoans and parasites, through to all plants, all animals and all of human kind - EVERY living thing has DNA. DNA is what defines life in the broadest sense.

Proteins are responsible for the size, shape and operation of the cell. They make each tissue structurally and functionally different, but still work together in a highly precise electrochemical synchrony. But ultimately, it’s our genes that hold all of the instructions to make every one of the proteins within our cells. Without our genes, we would be nothing more than a salty soup of random amino acids.

Epigenetics and the environment contribute to the way genes are expressed. Epigenetics are “tags” on the strand of DNA that act to promote or silence the expression of certain genes (this will be discussed in more detail in chapter 12). Environmental factors (the components that make up the world external to our bodies) can influence genes and epigenetic markers. The environment can cause genetic mutations or new epigenetic marks that change the function of a particular gene, and depending on which cell they effect (a very active embryonic cell or a quiet adult cell) will largely determine the eventual outcome. The environment is more influential to our genetic expression than epigenetics.

Still, on average only about 25% of the expression of a complex trait is related to environmental factors. So while the environment is important, it is still outdone 3:1 by our genome.

Yes, epigenetics and the environment are important, but they influence, not control, the genome.

Perception

We live in a sensory world. The five senses are vital in providing the input we need for our brain to understand the world and meaningfully interact with it.

Different organs are needed to translate the optical, chemical or mechanical signals into electrical signals. Different parts of our brain then interpret these signals and their patterns. We discussed this in more detail in chapter 1.
Our genes significantly influence this process. For example, if someone is born with red-green colour blindness then how he or she interprets the world will always be subtly different to someone with normal vision. Or a person born with congenital deafness will always interpret his or her environment in a different way to someone with full hearing. I’ve highlighted these two conditions because they provide stark examples to help demonstrate the point, but there are many unique genetic expressions in each of the five senses that subtly alter the way each of us perceives the world around us.

So while we may all have the same photons of light hitting our retinas, or the same pressure waves of sound reaching our ears or touch on our skin, how our brains receive that information is slightly different for every individual. The information from the outside world is received by our sensory organs, but it is perceived by our brain, and even small differences in perception can have a big impact on the rest of the system.

**Personality**

Personality is “the combination of characteristics or qualities that form an individual’s distinctive character” [3]. Formally speaking, personality is, “defined as constitutionally based tendencies in thoughts, behaviors, and emotions that surface early in life, are relatively stable and follow intrinsic paths of development basically independent of environmental influences.” [41]

Professor Gregg Henriques explained it well in Psychology Today, “Personality traits are longstanding patterns of thoughts, feelings, and actions which tend to stabilize in adulthood and remain relatively fixed. There are five broad trait domains, one of which is labeled Neuroticism, and it generally corresponds to the sensitivity of the negative affect system, where a person high in Neuroticism is someone who is a worrier, easily upset, often down or irritable, and demonstrates high emotional reactivity to stress.” [42] The other four personality types are Extraversion, Agreeableness, Conscientiousness, and Openness to Experience.

Gene x environment studies suggest that personality is highly heritable, with up to 60% of personality influenced by genetics [43], predominantly through genes involved in the serotonin [10] and dopamine systems [11, 44]. The “non-shared environment” (influences outside of the home environment) contributes heavily to the remainder [45, 46].

Personality is like a filter for a camera lens, shaping the awareness of our emotional state for better or worse, thus influencing the flow on to our feelings (the awareness of our emotions), our thoughts, and our actions.

**Physiology**

Watkins describes physiology as streams of data that are provided from the different parts of your body, like the heart rate, your breathing rate, the oxygen in your blood, the position of your joints, the movement of your joints, even the filling of your bladder telling you that you need a break soon.

All of these signals are constantly being generated, and collated in different parts of the brain. Some researchers consider them positive and negative depending on the data stream and the signal its providing. They coalesce into emotion [47].

**Emotion**

According to Watkins, “emotion” is the sum of all the data streams of physiology, or what he described as “E-MOTION ... Energy in MOTION.” [47] In this context, think of emotion as a bulls-eye spirit-level of our body systems. The different forces of our physiology change the
“level” constantly in different directions. Emotion is the bubble that marks the central point, telling us how far out of balance we are.

In the interest of full disclosure, I should mention that although emotion is a familiar concept, the work of literally thousands of brilliant minds has brought us no closer to a scientifically validated definition of the word “emotion”. Some psychologists and researchers consider it vague and unscientific, and would prefer that it not be used altogether [8].

I’ve retained it because I think it’s a well-recognised word that conceptually describes the balance of physiological forces.

**Feelings**

“Feelings” are the perception of emotion.

I discussed earlier in the chapter that what we perceive is different to what we “see” because the subtle genetic differences in our eyes and brains causes the information to be processed differently between individuals. The same applies to the perception of our emotion.

As I wrote earlier, personality is largely determined by our genetics with contributions from our environment [45, 46]. The emotional signal is filtered by our personality to give rise to our feelings. Classically, an optimistic personality is going to bias the emotional input in a positive, adaptive way while a pessimist or neurotic is going to bias the emotional signal in a maladaptive way.

That’s not to say that an optimist can’t have depressed feelings, or a neurotic can’t have happy feelings. In the same way that a coloured lens will allow a lot of light through but filter certain wavelengths out, most of our emotional state of being will come through the filter of our personality but the feelings will be subtly biased one way or another.

**Executive Functions**

Executive function of the brain is defined as a complex cognitive process requiring the co-ordination of several sub-processes to achieve a particular goal [48]. These sub-processes can be variable but include working memory, attention, goal setting, maintaining and monitoring of goal directed action and action inhibition. In order to achieve these goals, the brain requires flexibility and coordination of a number of networks and lobes, although mainly the prefrontal cortex, parietal cortex, anterior cingulate and basal ganglia, and the white matter tracts that connect them.

Executive functions process the incoming information and decide on what goals are best given the context, then plan the goals, execute them to the motor cortices, and monitor the action. Research work from Marien et al [49] demonstrates that unconscious/implicit goals can divert resources away from conscious goals especially if it is emotionally salient or otherwise strongly related. They also confirm that conscious awareness is not necessary for executive function but that implicit goals can be formed and executed without conscious involvement.

**Thoughts**

In chapter one we discussed the conscious broadcast model of thought. Baars [18, 20] noted that the conscious broadcast comes into working memory which then engages a wider area of the cerebral cortex necessary to most efficiently process the information signal. We perceive thought most commonly as either pictures or sounds in our head (“the inner monologue”), which corresponds to the slave systems of working memory. When you “see” an image in your mind, that’s the visuospatial sketchpad. When you listen to your inner monologue, that’s your phonological loop. When a song gets stuck in your head, that’s your phonological
loop as well, but on repeat mode.

There is another slave system that Baddeley included in his model of working memory called the episodic buffer, “which binds together complex information from multiple sources and modalities. Together with the ability to create and manipulate novel representations, it creates a mental modeling space that enables the consideration of possible outcomes, hence providing the basis for planning future action.” [13]

Deep thinking is a projection from your brain's executive systems (attention or the default mode network) to the central executive of working memory, which then recalls the relevant information from long-term memory and directs the information through the various parts of the slave systems of working memory to process the complex details involved. For example, visualizing a complex scene of a mountain stream in your mind would involve the executive brain directing the central executive of working memory to recall information about mountains and streams and associated details, and project them into the visuospatial sketchpad and phonological loop and combine them via the episodic buffer. The episodic buffer could also manipulate the scene if required to create plans, or think about the scene in new or unexpected ways (like imagining an elephant riding a bicycle along the riverbank).

Even though the scene appears as one continuous episode, it is actually broken up into multiple cognitive cycles, in the same way that images in a movie appear to be moving, but are really just multiple still frames played in sequence.

**Action**

Action is the final step in the process, the output, our tangible behaviour.

Our behaviour is not the direct result of conscious thought, or our will (as considered in the sense of our conscious will).

We discussed this before when we talked about our choices in chapter 1. There are two main pathways that lead from sensory input to tangible behaviour – various automated pathways that take input from the thalamus, deep in the brain, and sent to motor circuits in the supplementary motor area and motor cortex of the brain. These can be anything from evasive “reflex” actions** to rehearsed, habituated motor movements, like driving. Then there is the second pathway, coming from the executive areas of our brain, that plan out options for action, which are reviewed by the pre-supplemental motor area and the default mode network. This second pathway is amenable to conscious awareness. Like thought, the projection of different options for action into our consciousness helps to engage a wider area of cerebral cortex to process the data. Most of the possible plans for action have already been rejected by the implicit processing of our executive brain before consciousness is brought in to help. Once an option has been selected, the action is sent to the pre-supplementary motor area, the supplementary motor area, the basal ganglia and finally the motor cortex.

According to the model proposed by Bonn [15], the conscious network has some feedback from the control network of our brain, providing real time context to actions about to be executed, and a veto function, stopping some actions at the last minute before they are carried out. This is largely a function of the basal ganglia [50], with some assistance from working memory.

**CBT and the CAP**

Cognitive behavioural therapy is the most successful psychological therapy in the history of mankind, at least in terms of published data. Originally developed by Beck in the mid-60’s [51], it has been applied to more and more conditions, with ongoing success.
CBT relies on the part of the CAP model involving feelings, thoughts and actions. According to the original theory of Beck [51, 52], the input of thoughts is more powerful than feelings, and thus, changing your thoughts is the first step in the process of behavioural change. This is the basis of Cognitive Behavioural Therapy – that changing your maladaptive patterns of thinking will change your behaviour and also the way you feel. Dr Leaf’s interventions, such as her 21-day Brain Detox and her Brain Sweep, are loosely built on the same principles as CBT.

But CBT remains the original therapy based on the thoughts/actions/feelings loop, and has been proven to be effective in a wide range of psychological dysfunctions including depression [53: p215-38], anxiety [54] and chronic pain [55] to name a few. As research has progressed, Beck’s original theory - that a change in thinking is required for a change in behaviour - has fallen off its pedestal. The cognitive part of Cognitive Behavioural Therapy has been found to be much less important to the process than first proposed. This will be discussed further in chapter 7.

Other feedback loops within the CAP model

There are other feedback loops as well, from action back to sensory input as our sensors in our muscles, joints, ears, eyes and skin detect the actions that we make as we perform them (ie: we hear ourselves speak, or we feel ourselves move).

The High and Low Roads

In chapter 1, I talked about a model of thought called the Dual Systems Model - the high and low roads of thought processing.

System 1 involves a set of different subsystems that operate in parallel, delivering swift and intuitive judgments and decisions in response to our perceptions. System 1 is unconscious, automatic and guided by principles that are, to a significant extent, innately fixed and universal among humans. System 2 is the system that involves “thought” in relation to my working definition. It is conscious and reflective in character, and proceeds in a slow, serial manner, according to principles that vary among both individuals and cultures [28].

In terms of the Cognitive-Action Pathways Model, System 1 (the “Low Road”), travels directly between perception and action, bypassing the filtering of the several cognitive steps in between. It’s much faster because it involves less processing, but it’s also less refined. It’s a pathway of stimulus-response, what makes up our instincts and raw reflexes.

System 2, the “High Road”, is the other pathway taken through the steps of physiology, emotion, feelings and thoughts. System 2 is much slower, although it’s more refined and has much more power, because each step in the system hones the raw data to produce an output that is more specific to the context of the stimulus in terms of both space and time.

Thought Independent Action, Stimulus Independent Thought, and Parasomnias

System 1 of the Dual Systems Model describes our reflexes, our habits and our instincts, which I categorize into a group called Thought Independent Actions. These are actions in which our cognitive functions are bypassed.

Another variation within the Cognitive-Action Pathways Model is the concept of Stimulus Independent Thought.

The two different systems can run at the same time. In the example I used in chapter 1, sometimes I can be driving home at the end of a long day and find myself drifting off into thinking about something inane, then realise I’ve driven a couple of kilometres on autopilot. When performing a menial, routine task, (or even a reasonably complex habituated task, like
driving), our sensory signals are passing through the deeper parts of our brain and surfacing as actions while our Default Mode network and working memory are on a completely different tangent.

Dreaming is a different state altogether, in which our brain initiates a self-generated program of reorganizing the stored memories in our brain. The characteristic of dreaming as opposed to waking consciousness is that dreaming lacks awareness, it is incoherent, and it is diminished in thought and memory. Whenever we sleep, we dream, but we rarely remember dreams or have awareness of them [35]. If we wake up during a dream, some of what we dreamt will be left over in our short-term memory system and becomes available to our thoughts. But more often, we simply don’t remember them.

Parasomnia is a medical description for a condition in which the inhibitory reflexes that are normally applied when we are in a state of NREM sleep are missing, which means that what we dream about can move to the Action step. They are more commonly referred to as sleep-walking and sleep-talking, although sometimes the parasomnias can be complex motor patterns like eating [56]. One of my patients once had a parasomnia in which she drove her car.

In summary, the Cognitive-Action Pathways Model is a way of describing the context of thoughts to other neurological processes, and how they all interact. It shows that conscious thoughts are one link of a longer chain of neurological functions between stimulus and action - simply one cog in the machine. Thoughts are an important cog, but they are dependent on a number of other processes or they can be bypassed altogether. Thoughts are not the driver of our consciousness or our free will, but merely a bit player.

AUTISM SPECTRUM DISORDER – A REAL LIFE EXAMPLE OF THE COGNITIVE-ACTION PATHWAYS MODEL

Small changes in the early processes within the Cognitive-Action Pathway model can snowball to effect every other part of the process. A real life example of this is ASD, or Autism Spectrum Disorder.

ASD has been present since time immemorial. Numerous bloggers speculate that Moses may have had ASD, while a couple of researchers proposed that Samson was on the spectrum (although their evidence was tenuous [57]). Thankfully, autism is no longer considered a form of demon possession or madness, or schizophrenia, or caused by emotionally distant “refrigerator mothers”, nor treated with inhumane experimental chemical and physical “treatments” [58, 59].

The autism spectrum is defined by two main characteristics: deficits in social communication and interaction, and restricted repetitive patterns of behaviour. People on the autism spectrum also tend to have abnormal sensitivity to stimuli, and other co-existing conditions like ADHD. It’s hard to fully explain these definitions in a paragraph, but for completeness, I’ve listed the full DSM-5 diagnostic criteria for ASD in appendix A. The new criteria are not without their critics [60-62], but overall, reflect the progress made in understanding the biological basis of autism.

ASD is recognized as a pervasive developmental disorder secondary to structural and functional changes in the brain that occur in the womb, and can be detected as early as a month after birth [63]. In the brain of a foetus that will be born with ASD, excess numbers of dysfunctional nerve cells are unable to form the correct synaptic scaffolding, leaving a brain that is large [64, 65], but out-of-sync. The reduced scaffolding leads to local over-connectivity within regions of the brain, and under-connectivity between the regions of the brain [66]. The majority of the abnormal cells and connections are within the frontal lobe,
especially the dorsolateral prefrontal cortex and the medial prefrontal cortex [67], as well as the temporal lobes [68]. The cerebellum is also significantly linked to the autism spectrum [69]. There is also evidence that the amygdala and hippocampus, involved in emotional regulation and memory formation, are significantly effected in ASD [66].

There is also strong evidence for an over-active immune system in an autistic person compared to a neurotypical person, with changes demonstrated in all parts of the immune system, and the immune system in the brain as well as the rest of the body [70]. These immune changes contribute to the reduced ability of the brain to form new branches as well as develop new nerve cells or remove unnecessary cells.

There are a number of environmental and epigenetic associations linked to autism. These include disorders of folate metabolism [71, 72], pollutants [73], fever during pregnancy [74] and medications such as valproate and certain anti-depressants [75, 76] which are linked with an increase in autism***. Supplements such as folate [71, 77], omega-6 polyunsaturated fatty acids [78] and the use of paracetamol for fevers in pregnancy [74] have protective effects.

Although these factors are important, genes outweigh their influence by about 4:1. Twin studies suggest that between 70-90% of the risk of autism is genetic [79, 80]. Individual gene studies have only shown that each of the many single genes carry about a one percent chance each for the risk of autism [66]. It’s been proposed that the hundreds of genes linked with autism [66, 81] are not properly expressed (some are expressed too much, some not enough). The resulting proteins from the abnormal gene expression contribute to a different function of the cell’s machinery, altering the ability of a nerve cell to fully develop, and the ability of nerve cells to form connections with other nerve cells [82]. The effects are individually small, but collectively influential [80]. Autism is considered a complex genetic disorder involving rare mutations, complex gene × gene interactions, and copy number variants (CNVs) including deletions and duplications [83].

According to the Cognitive-Action Pathways model, the triad of the environment, epigenetics, and genes influence a number of processes that feed into our actions, thoughts, perceptions, personality and physiology. In ASD, the starting place is language processing.

New born babies from as young as two days old prefer listening to their own native language [84], which suggests that we are born already pre-wired for language. Auditory stimuli (sounds) are processed in the temporal lobes, including language processing. In neurotypical people, language processing is done predominantly on the left side, with some effect from the right side. But in people with autism, because of the abnormal wiring, there is only significant activity of the right temporal lobe [68]. Even more, from data so recent that it’s pending publication, loss of the processing of information of the left temporal lobe reversed the brains orientation to social and non-social sounds, like the sound of the babies name [63].

The change in the wiring of the left and right temporal lobes then alters the processing of language, specifically the social significance of language and other sounds. So already from a young age, people with autism will respond differently to environmental stimuli compared to a neurotypical person.

In the same way, the fusiform gyrus is part of the brain that processes faces. It’s quite specific to this task in a neurotypical person. However, the altered wiring of the brain in someone with autism causes a change, with different parts of the brain having to take up the load of facial processing [85].

Each time that one part of the brain can’t perform it’s normal function, the other parts take up the load. However that reduces the capacity for those parts of the brain to perform their own normal functions. In the case of the temporal lobes and the fusiform areas, this results in a
reduced ability to discern subtleties especially those related to recognizing social cues. A neurotypical person and an autistic person could be standing in front of the same person, listening to the same words, and seeing the same facial expressions, but because of the way each persons brain processes the information, the perception of those words and cues can be completely different. This demonstrates how genetic changes can lead to changes in the perception of normal sensory input, resulting in differences in the physiological response, emotions, feelings, thoughts and actions, despite identical sensory input.

Physiology

The same changes that effect the cerebral cortex of the brain also have an influence on the deeper structures such as the hippocampus and the amygdala. The hippocampus is largely responsible for transforming working memory into longer term declarative memory. Studies comparing the size of the hippocampus in ASD children have shown an increase in size compared with typical developing children [86]. Combined with the deficits in the nerve cell structure of the cerebellum [69], autistic children and adults have a poor procedural memory (action learning, regulated by the cerebellum) and an overdeveloped declarative memory (for facts, regulated by the hippocampus). This has been termed the “Mnesic Imbalance Theory” [87].

The amygdala is also functionally and anatomically altered because of the changes to the nerve cells and their connections. The amygdala is larger in young children with ASD compared to typically developing children. As a result, young ASD children have higher levels of background anxiety than do neurotypical children [88]. It’s proposed that not only do ASD children have higher levels of background anxiety, they also have more difficulty in regulating their stress system, resulting in higher levels of stress compared to a neurotypical child exposed to the same stimulus [89].

Personality

On a chemical level, autism involves genes that encode for proteins involved in the transport of key neurotransmitters, serotonin and dopamine. Early evidence confirms the deficits of the serotonin and dopamine transporter systems in autism [90]. These neurotransmitters are integral to processing the signals of mood, stress and rewards within the brain, and as discussed in the last chapter, are significantly involved in the genesis of personality.

The abnormal neurotransmitter systems and the resulting deficiencies in processing stress and rewards signals contribute to a higher correlation of neuroticism and introverted personality styles in children with autism symptoms [91, 92].

So people with autism genes are going to process stress and rewards in a different way to the neurotypical population. As a result, their feelings, their thoughts and their resulting actions are tinged by the differences in personality through which all of the incoming signals are processed.

Actions

The underlying genes and neurobiology involved in autism also effect the final behavioural step, not only because genes and sensory input influence the personality and physiology undergirding our feelings and thoughts, but also because they cause physical changes to the cerebellum, the part of the brain involved in fine motor control and the integration of a number of higher level brain functions including working memory, behaviour and motivation [26, 69].

When Hans Asperger first described his cohort of ASD children, he noted that they all had a tendency to be clumsy and have poor handwriting [93]. This is a good example of how the
underlying biology of ASD can effect the action stage independently of personality and physiology. The cerebellum in a person with ASD has reduced numbers of a particular cell called the Purkinje cells, effecting the output of the cerebellum and the refined co-ordination of the small muscles of the hands (amongst other things). Reduced co-ordination of the fine motor movements of the hands means that handwriting is less precise and therefore less neat.

A running joke when I talk to people is the notoriously illegible doctors handwriting. One of the doctors I used to work with had handwriting that seriously looked like someone had dipped a chicken’s toes in ink and let it scratch around for a while. My handwriting is messy - a crazy cursive-print hybrid - but at least it’s legible. I tell people that our handwriting is terrible because we spent six years at medical school having to take notes at 200 words a minute. But it might also be that the qualities that make for a good doctor tend to be found in Asperger’s Syndrome, so the medical school selection process is going to bias the sample towards ASD and the associated poor handwriting (Thankfully, those that go on to neurosurgery tend to have good hand-eye coordination).

But if your educational experience was anything like mine, handwriting was seen as one of the key performance indicators of school life. If your handwriting was poor, you were considered lazy or stupid. Even excluding the halo effect from the equation, poor handwriting means a student has to slow down to write neater but takes longer to complete the same task, or writes faster to complete the task in the allotted time but sacrificing legibility in doing so.

Either way, the neurobiology of ASD results in reduced ability to effectively communicate, leading to judgement from others and internal personal frustration, both of which feedback to the level of personality, molding future feelings, thoughts and actions.

Thought in ASD

By the time all the signals have gone through the various layers of perception, personality and physiology, they reach the conscious awareness level of our stream of thought. I hope by now that you will agree with me that thought is irrevocably dependent on all of the various levels below it in the Cognitive-Action Pathways Model. While thoughts are as unique as the individual that thinks them, the common genetic expression of ASD and the resulting patterns in personality, physiology and perception lead to some predictable patterns of thought in those sharing the same genes.

As a consequence of the differences in the signal processing, the memories that make their way to long-term storage are also going to be different. Memories and memory function are also different in ASD for other neurobiological reasons, as described earlier in the chapter with the Mnesic Imbalance Theory.

SUMMARY

The Cognitive-Action Pathways model is a way of describing the context of thoughts to other neurological processes, and how they all interact. It shows that conscious thoughts are one link of a longer chain of neurological functions between stimulus and action - simply one cog in the machine. The autistic spectrum provides a good example of how changes in genes and their expression can dramatically influence every aspect of a person’s life - how they experience the world, how they feel about those experiences, and how they think about them.

I used autism as an example for this chapter because autism is a condition that’s pervasive, touching every aspect of a person’s life, and provides a good example of the extensive consequences from small genetic changes. But the same principles of the Cognitive-Action Pathways Model apply to all aspects of life, including conditions that are considered
pathological, but also to our normal variations and idiosyncrasies. Small variations in the genes that code for our smell sensors or the processing of smells can change our preferences for certain foods just as much as cultural exposure. Our appreciation for music is often changed subtly between individuals because of changes in the structure of our ears or the nerves that we use to process the sounds. The genetic structure of the melanin pigment in our skin changes our interaction with our environment because of the amount of exposure to the sun we can handle.

This chapter was about setting out the place that our thoughts have in the grand scheme of life. It’s not a plug for genetic pre-determination. We are not a victim of our genes, but at the same time, we are not the master and commander either.

In the next chapter, I want to explain why the Cognitive-Action Pathways Model provides real truth, and why it’s liberating rather than debilitating.

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CHAPTER 3 - AND THE TRUTH SHALL SET YOU FREE

Einstein is credited with saying, “Everybody is a genius. But if you judge a fish by its ability to climb a tree, it will live its whole life believing that it is stupid.”’ It’s a great quote; notwithstanding the minor discrepancies that: (1) not everyone’s a genius, and (2) Einstein didn’t actually say it [94].

Inaccuracies aside, the point the quote is making is still mostly true. Unrealistic expectations about someone or something make for failure and disappointment for all concerned.

When Jesus said, “And you shall know the truth, and the truth shall set you free”, he was undoubtedly speaking words of profound spiritual guidance, but the phrase also holds in the most general sense. When you understand what’s really going on, you are free. Imagine you’re stuck in a maze. With no directions, or with wrong directions, you face hours of fruitless wandering and frustration. You are trapped. When you understand the right directions, you are free to navigate out of the maze and you are liberated.

The same metaphor applies to thoughts and behaviours. We all have behaviours that we don’t like, and that we want to change. Sometimes we can change them ourselves, but we inevitably find ourselves stuck in a pattern of other thought or actions that are not what we want. But as hard as we try, we remain trapped, unable to move through the maze, frustratingly trying over and over again to find our way out and remaining exactly where we were when we started.

If you happened to be trapped in a maze, the most useful thing to have would be a map, or at least someone with a map that could help navigate. The wrong directions, or no direction, both guarantee more failure. The right directions give hope, and eventually, freedom. This is what this chapter, and indeed, the whole book, is all about – the right directions, hope and freedom.

In the last chapter I used autism as an example of how the Cognitive-Action Pathways Model works in a real life. But the model doesn’t just apply to autism, but for all of our behaviours, in all aspects of our lives. In this chapter, I want to explain how the Cognitive-Action Pathways Model can be applied to other part of our lives, both in disease states, but also in the course of our daily lives.

By understanding the relationships of our actions to our thoughts and the rest of our biology, we see the right steps, get the right directions, and finally free ourselves from the maze. At
the same time, we can remove the failure and the weight of guilt and disappointment that unrealistic expectations causes us.

Remember: The right directions, hope and freedom. They are our goals.

GENES, ENVIRONMENT AND PRE-DETERMINATION

The popular media sometimes gives the impression that our fate rests with our genes. It hasn’t always been this way. In the early 20th century, eugenics was a powerful philosophy. Eugenics is the science of improving a population by controlled breeding to increase the occurrence of desirable heritable characteristics. It was based on the idea that genes were solely responsible for physical traits. The pendulum swung away from the determinism of genes in the 1940’s as psychiatrists moved to the behaviorism model promoted by B.F. Skinner. The pendulum of public opinion swung back towards the absolute determinism of genes in the late 20th century as better techniques saw the discovery of gene mutations as the cause of disease.

In reality, both genes AND the environment make us who we are. It’s wrong to think that our genes control us completely, just as it’s wrong to say our genes have no effect at all.

In modern research, biologists have studied the question of the influence of nature (genes) versus nurture (the environment) with GxE studies, shorthand for Gene x Environment. Using the best available data involving large numbers of people with the particular trait and without it, common gene variations are analysed and the average effect of those genes is compared to the influence of the environment. The result is expressed as a percentage split. For example, eighty-eight percent of the chance that a person will develop insulin dependent diabetes is related to their genes, while the remaining twelve percent is determined by their environment [95]. On a population level, the power of genes and the environment can be averaged, and shown by GxE studies. But the genetic risk for an individual finds its own unique level because of different mutations, polymorphisms and variants each have different levels of expression.

Therefore, genes have a significant impact on our biology but they do not have the final say in everything. Genes are like a set of corrals, limiting the area in which we have the power to choose. To take the most obvious example, my genes determine my gender and my athletic ability. I can partially overcome one genetic limitation but never overcome the other. That is, if I worked supremely hard, I could run a five-minute mile, but no matter how hard I tried, I could never change my male genes, become pregnant or give birth (I’m not too unhappy about that). One set of genes is impossible to overcome, the other I could choose to overcome, but it would take a lot of extra work, which still limits my ultimate decisions.

This is important for two reasons. Whatever your family history or genetic lineage is, it doesn’t completely negate personal choice. You may have a higher risk of depression because of your lineage, but you can choose to engage in appropriate therapy to help negate that risk. At the same time, don’t blame yourself if you try to prevent an unwanted trait and it occurs anyway. You can’t control everything.

For example, you may have a genetic risk of depression of 66%. With the right tools, you may halve your risk, which is good going by any standards. But that still leaves you with a 33% chance of suffering depression, and if you end up being the one out of three, there’s no shame in it.

There was a study of people who had pre-diabetes published in the Lancet in 2001, who through lifestyle modification (ie: radically changing their environment), managed to achieve an average 58% reduction in their risk of developing diabetes. Still, after 4 years, 11% of
them developed diabetes anyway [96]. This is a good example of how choices can sometimes change your ultimate destiny.

So I’ll say it again, because this is important. Genes don’t completely negate your power to choose, but they set limits over what choices you can make, and they have a say in the final outcome of your choices.

THOUGHT IN ITS PROPER PLACE

Placing your thoughts at the top of the chain as the most influential step in the process is like placing the Earth in the centre of the Solar System. It seems intuitively correct. Aristotle declared that the Earth is stationary and must be the centre of the universe, since the Earth doesn’t seem to move, rather, everything else moves around us. In the same way, Descartes mused, “I think, therefore I am”, noting how our thoughts are so integral to our being that they must be the centre of it.

Aristotle’s view disabled scientific reasoning and discovery for centuries until Copernicus proposed the view that the Earth wasn’t central, but was actually the third planet circling the central sun.

In the same way, by getting thought in its proper place, everything else in the process aligns and enables us to move forward purposefully. We see that thought is itself dependent on a number of steps beyond our conscious influence.

This puts the “helpful” advice that we get from other people into perspective. Like Alan Watkins said in his TEDx presentation, “So if you feel anxious, for example, it’s no good me saying to you, ‘Don’t worry.’ You’ll have experienced that doesn’t work.” [47] How often do your friends tell you, “Don’t worry”, or you say the same to them? It’s fairly redundant, because no matter how much they say it, it doesn’t stop you from worrying.

Deification of thought only produces frustration, guilt and feelings of failure. My son loves the show, “Mythbusters”. There was a recent episode [97] in which they were testing some “Battle of the Sexes” myths, specifically that men don’t ask for directions when they get lost. They took ten men and ten women, put them in the middle of suburbia without a map, and gave them a misleading set of directions. The result was, of course, that all twenty volunteers got lost.

The reactions of the volunteers provided some interesting insights. They all drove around trying to retrace their steps, trying to figure out where they went wrong, trying not to look stupid on an internationally broadcast TV show. The more they drove around, the more lost they became. They all got frustrated. You could see their anxiety rising as each time they tried to go back to their starting point in the endless maze of uniformly bland streets and houses, they would find themselves driving around in circles. The men did this for an average of four whole minutes; the women did it for over five minutes. Two of the volunteers drove completely lost for a full fifteen minutes before the hosts pulled them off the course to put them out of their misery.

It didn’t matter how hard they tried, either to follow the (incorrect) instructions better, or try and rely on their own skills. They didn’t find their way to their desired location until they asked the “neighbours” (people planted around the streets by the producers) to give them directions.

Thoughts are much the same. It doesn’t matter how hard you try, or how good you are. If you try and fix your thought pattern, you’ll wind up confused, frustrated and entirely stuck. It’s no good telling yourself or someone else to “just try harder”, or “I just need to change my thoughts from toxic to non-toxic” or “I just need to become a better person” or anything else
for that matter.

Admittedly the surge of hope that accompanies pop-psychology self-help mantras does make you feel better for a while, a bit like the first four days of a diet. But they inevitably lead to a crash because they’re trying to fix the “symptom” of dysfunctional thinking with more thinking. These repeated failures reinforce feelings of guilt and shame, the despair of failure. These feelings then lead to guilt about having guilt, or anxiety over having anxiety.

Having thought in its proper place makes it easy to understand why pop psychology and self-help mantras don’t work. It also allows you to make changes that do work, realigning the upstream processes where you can, so that the important outcomes like awareness and actions are aligned with your values.

**DOES THE CAP MODEL HAVE ROOM FOR CHOICES?**

As I said before, our genes have a corralling effect, limiting some choices, but allowing enough space in others that to overcome them by efficient effort and determination.

In order for us to have choices, there needs to be feedback points where the active decisions we make have an impact on the earlier steps in the process, before they reach our thoughts and actions. There are three places in the model in which our choices actively influence the steps which then feedback into the model and influence our thoughts and actions for better or worse.

1. **Action activation**

The relationship between feelings, thoughts and actions has been described for many decades now, and underpins the success of Cognitive Behaviour Therapy, or CBT for short.

CBT is actually less of a single, specific therapy, and more of a family of similar therapies that arise from the core relationship of feelings, thoughts and behaviour. CBT has proven benefits in a wide variety of psychological disorders, physical problems and unwanted habits, including anxiety disorders and phobias, depression, low self-esteem, uncontrollable anger, substance abuse, problem gambling, eating disorders, insomnia, marriage or relationship problems and chronic pain management [98].

Cognitive Behaviour Therapy has two main components, Cognitive Therapy, and Behaviour Therapy. Cognitive therapy stems from the seminal work by Beck and his colleagues, first published in 1979 and revised in 1985. It proposes that “symptoms and dysfunctional behaviors are often cognitively mediated and, hence, improvement can be produced by modifying dysfunctional thinking and beliefs.” [52] Beck proposed a number of ways to challenge these dysfunctional modes of thinking, such as become aware of the dysfunctional thoughts, testing how true they are, finding external evidence to determine if they are true or false, examining their consequences, and generating alternative explanations [51].

Behaviour therapy is another very broad group of therapies, and can be considered as any suggested change in behaviour to improve health and wellness. Technically, anyone who shares a problem and is given an action to follow, could be considered to have been treated with behavioural therapy. The origin in modern psychology could probably be found in the work of Skinner in the 1940’s, and his model of radical behaviorism [99]. Behaviour therapy remains loosely based on Skinner’s model, but has broadened to include therapy involving operant learning as well as therapies focused on value-based action in spite of one’s thought process [100].

When the two approaches combine into CBT, the data is incredibly supportive. But what does recent evidence say about the effectiveness of each step in the process in achieving the
desired outcome? Which is the most effective: cognitive therapies, behavioural therapies, or are they as equally as each other?

There is some evidence in favour of cognitive approaches generally, and specifically for Social Anxiety Disorders [51]. However a number of meta-analyses have concluded that adding cognitive therapy to behaviour therapy offers no incremental benefit over behavioural therapy alone [101]. This was confirmed by a large randomised controlled trial comparing behavioural therapy and cognitive therapy side by side with medication for depression [102].

In other words, therapies aimed at fixing thinking works equally as well as therapies aimed only at promoting therapeutic action. However, when thinking therapies are added to behaviour therapies, they add no extra benefit over and above the behaviour therapies alone [101]. This suggests that it is behaviour change that is the driver of the therapeutic effects of traditional CBT. If thinking therapies were the driving force of the C/BT partnership, the addition of cognitive therapy to behaviour therapy should have an incremental effect.

That cognitive therapy works equally well as behavioural therapy may be related to their fundamental similarities. Dobson et al explains, “Behavioural Activation is implemented in a manner that is intended to both teach coping skills and to reduce future risk. The same is true for Cognitive Therapy, which adds an emphasis on cognitive change, but otherwise takes a similar skills-training approach.” [102] In other words, cognitive therapy is just behavioural therapy with bling.

This is further evidence to justify the recurrent theme of this section - just trying to think better does not make your life better. In most cases, changing your thinking is the result of, not the cause of, adaptive action activation.

New forms of CBT, such as Acceptance and Commitment Therapy, confirm the predominance of behavioural activation over cognitive restructuring, by showing therapeutic improvements in many different conditions through value-directed action in spite of dysfunctional thought processes. ACT refers to “defusion”, which is “the process of relating to thoughts as just thoughts so as to reduce their automatic impact” [100].

The take home message for the Cognitive-Action Pathways model is that Action Activation is nothing more than learning a better way or finding a new solution to an old problem. In practical terms, improvement comes with better coaching, a principle that applies as much to the sporting field as it does to life in general. Like the volunteers on Mythbusters, when they stopped and asked someone else for the right directions, their frustration and confusion stopped and they found their way out of their maze. If you want to find your way out of your own maze of frustration and confusion, find someone who can provide the right solutions, and ask for their help.

2. Operant learning loop

Whatever actions we choose, we automatically acquire feedback through our sensory input (our senses). Whatever the action is, all of the senses are involved in receiving data so that the action can be encoded, correlated and stored, our brains building a base of knowledge for future use.

For example, if I choose to eat an apple, I would look at the apple, smell the apple, feel the apple with my fingers, assess the movement of my hand to the apple and back to my mouth, feel the apple with my lips and mouth, and taste the apple with my tongue once I bit into it. I would also hear the crunch of the apple with my ears, and the response or reaction of people of things around me as I eat the apple. All of this data is received by the sense organs and passed up the processing chain. My brain perceives this data, as well as what it does to my
physiology, in turn changing my emotional state, and the awareness of this emotional state in
the form of feelings and thoughts. This awareness is both compared to previous memories
and written into a memory of its own, as well as all of the information processed to this point
culminating in the process of performing my next action.

If the apple is firm to touch, crunchy, cool, sweet and juicy, my brain will perceive all of
these things, and the chances are that they would act positively on my internal physiology,
combining into a pleasant emotional state which is perceived as a good feeling. This will be
entered into my memory bank. Next time I come across a firm round fruit, the memories of
the apple experience will be recalled and used for me to judge my next action, which will
probably be to eat the next apple. The sensations perceived when I eat the next apple will be
compared to the sensations stored in memory from the last time, and new memories will be
formed based on the combination of both experiences. If the same process occurs many more
times, my brain will have a strong memory bank of good experiences from eating apples.

On the other hand, if one of the sensations perceived is not good - the skin is soft, the flesh is
dry, the taste is putrid or sour or I see a worm in it - then the chances are I will have an
displeasing emotional experience and I will become aware of unpleasant feelings. This will
be added to my memory bank. If everything about the experience was unpleasant, future
exposure to apples will result in retrieval of these unpleasant memories and my subsequent
actions will be entirely different than when I experienced the emotional state rendered by the
fresh apple.

In modern psychology, this feedback loop is known as Operant Learning, first formally
described by Skinner in the 1950’s, but it has always been an integral part of the basic human
experience.

This operant learning loop acts in two ways within the context of our personal choices.
Firstly, we learn the positive consequences of desired actions, which can have the effect of
correcting our maladaptive thought process. When we act according to our new set of
instructions and the unhelpful predictions of our maladaptive thinking don’t materialise as we
expected, new memories are stored, influencing future schemas while encouraging more of
the same actions. Secondly, the flip-side is also true, in that we can learn the unwanted
outcomes of unhelpful actions, and not perform them in the future.

3. Meditation mediation loop

Certain actions can also feedback to our physiology with minimal involvement of our sensory
receptors.

The action involves reducing sensory inputs by focusing on a simple, rhythmical source and
then regulating the act of breathing. By regulating the rate and depth of breathing, the
balance of the autonomic nervous system is tilted more towards the “rest and digest”
parasympathetic system and away from the “fight or flight” sympathetic system. This slows
the pace of the heart and makes it more even in its rhythm. It improves oxygenation of the
blood stream. It reduces the activation of the adrenal gland while increasing blood flow to the
gut, improving the absorption of nutrients.

This is basic meditation, something that has been show by numerous studies to have a myriad
of positive effects, both physical and psychological [103]. While meditation is often
considered an Eastern/Buddhist practice, meditation is not exclusively an Eastern tradition.
Indeed, the Bible discusses meditation several times, most often in the Psalms by King David
who often wrote of meditation upon God’s words (Psalm 63:6 and 119:148, for example).

But in terms of psychology, this form of meditation is nothing more than just quiet, controlled
breathing to help reign in the internal physiological systems. For example, in anxiety states or phobias, huge amounts of adrenaline surges in response to unconscious automatic protective mechanisms that are inbuilt in all of us, but which in some people are a little bit touchy. The sympathetic nervous system is pushed into overdrive, overwhelming the counterbalance of the parasympathetic system. The emotional state formed from the sum of the hyper-drive leads to anxious feelings and thoughts. If the action is to use relaxation techniques like meditation, the balance of the sympathetic and parasympathetic nervous systems can be restored, improving the feelings of anxiety as the underlying physiology is brought under control. This technique is proven to be useful, not only in anxiety disorders, but also in depression and states of psychological stress [104].

**BRINGING IT ALL TOGETHER**

When it all boils down to basics, this model is about understanding and empowerment.

Understanding: because we all need to recognise what it is about ourselves that we can’t change, what we can change, and what we need to change. We all have parts of us that we can’t change, or that we could change if we wanted to, but that would not have a great impact on the quality of our lives. Understanding the parts of our lives that are amenable and critical is the key to life change.

Empowerment: because when you recognise what it is about your life that you can’t change, you stop wasting precious strength and time fighting it. Instead, all of the effort that would have been needlessly spent on the unchangeable can be effectively spent on improving what needs to be, and can be, changed.

In chapter 2, I used autism as an example of how small changes in a persons genes can flow through to effect nearly everything about how they experience life. A person with high functioning autism (Aspergers Syndrome, to use the old classification) could spend their whole life trying to change themselves to be “more normal”. But rather than fighting to change their perception or their personality or their underlying physiology, a more effective strategy is to understand they will always have some oversensitivity to certain sensory stimuli. They may have a tendency to be more anxious. They may be more inclined to miss some social cues. How they think is going to be more literal, more analytical, and more concrete than other people. By pulling out of the needless, endless struggle with things that can’t be changed, they can move forward onto things that can be changed. They can be coached in social skills, giving them more confidence. More knowledge and confidence naturally eases anxiety, but when they do feel more anxious, they can accept that it’s there, but use the skills of basic meditation to reduce it. As a result of focusing on effective action, they have improved their quality of life without changing who they are.

The model applies to other problems too, and not just “mental illness”, but to anything. Do you, or have you suffered from depression? You’re in good company. Many others have, and still battle with it, including some of the most brilliant thinkers and leaders of modern times like Winston Churchill, Abraham Lincoln, performers like Kylie and Dani Minogue, and funny men like Jim Carrey and Zach Braff. It can be difficult to see anything other than despair, but trying not to think negatively doesn’t help, and often increases the struggle. Rather, taking that first action step slows, then reverses the downward momentum, even if it is simply going for a walk or sharing your despair with a health professional.

Frustrated by a bad habit? Frustration is common because they seem so hard to break. But is your habit really “bad”? So what if you chew your nails or scratch yourself? Those things don’t define your self worth. If they aren’t harming you in any way, why try and fight them? Perhaps you smoke? Smoking isn’t good for you, to be sure, but it doesn’t make you a bad
person or unworthy of love or joy. Genetics may increase your risk of starting, and reduce your chances of stopping, so understand that because the quitting process is hard doesn’t mean that you’re weak. Quite the opposite - acting on the choices that you do have and overcoming, even if it is slower or more difficult, actually shows that you are stronger. They key is to seek advice and take a step. Value-directed action is powerful and results in change even if your thoughts might not.

THE MOST POETIC OF SUMMARIES

The Cognitive-Action Pathways model, modern neurobiology and modern psychology help us approach our state of health in a scientific way. But decades before the foundational work they’re based on, a prayer was published that so neatly summarises the process of acceptance, change, values and mindfulness that it may as well be the prototype model for life enhancement. Shortly after it became published, it was officially adopted by Alcoholics Anonymous, and has assisted millions of people around the world as part of numerous mutual aid fellowships.

Although it was not officially titled when it was first published, it has become known as the Serenity Prayer.

God, give me grace to accept with serenity the things that cannot be changed, Courage to change the things which should be changed, and the Wisdom to distinguish the one from the other. Living one day at a time, Enjoying one moment at a time, Accepting hardship as a pathway to peace, Taking, as Jesus did, This sinful world as it is, Not as I would have it, Trusting that You will make all things right, If I surrender to Your will, So that I may be reasonably happy in this life, And supremely happy with You forever in the next. Amen.

FINAL REMARKS

Every two-bit life coach and pop-psychologist has some quasi-realistic seven step process. Most of them are useless. Some manage to marginally out-perform the placebo effect, but usually they’re the ones that through sheer luck, provide some behavioural therapy somewhere along the line.

Ultimately, thought is nothing more than the projection of a small part of the much larger information cycle within the brain, a single section of music within the grand symphony. Incorrectly assuming thought to be the conductor diverts attention away from the bigger picture, and targets the wrong part with the wrong solutions. Putting thought back in its proper place ensures that meaningful action can take place.

When it all boils down, I wrote this section (and the entire book for that matter) to help people. I know what it’s like to be struggling in the maze. I don’t want others to experience it if they don’t have to.
Like the Mythbusters example of the volunteers attempt to negotiate their suburban labyrinth, being given the wrong instructions eventually results in frustration and confusion. In this section, I have outlined what I believe is the correct solution. In the following sections, I will discuss how the theories and teachings proposed by Dr Caroline Leaf differ.

In section 2, we will look at the science of stress and resilience.

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SECTION 2
STRESS AND RESILIENCE

CHAPTER 4 – STRESS AND WHY IT’S NOT SO BAD

“Everybody knows what stress is, but no one really knows.” Hans Selye [105]

Hans Selye is considered the father of modern stress research. He was one of the first scientists to conceptualise and measure this ethereal force. As with some of the most important discoveries in the history of science, Selye came upon the discovery of what he termed the “alarm reaction” incidentally when he was injecting rats with impure ovarian extract, and noted that they became sick. He looked further at the physical changes in the rats and noted an unusual cluster of changes to their adrenal glands, thymus, spleen and gut [106]. He was able to reproduce the same responses by exposing the rats to cold temperatures, surgical injury, spinal shock, excessive muscular exercise, or intoxications with sublethal doses of drugs such as adrenaline, morphine or formaldehyde [107]. After years of research, he confirmed that ongoing exposure to the same physical conditions or drugs would follow the same three-stage process of initial physical changes, recovery and adaptation, then eventually exhaustion (and death). He called this model the “General Adaptation Syndrome.” [107]

The General Adaptation model was groundbreaking, and the sheer volume of work done by Selye brought his theories to the forefront of the scientific community. With time, the theory slowly descended from its place of adulation as other evidence came to light [108], but it has remained foundational, and Selye is still revered as the father of modern stress research. Selye was never more profound when he said that, “Everybody knows what stress is, but no one really knows.” [105] The actual word “stress” is a western buzzword that has spread to multiple nationalities and languages. It’s a concept that’s quite seductive. As Richard Shweder poignantly noted in the New York Times, “Imprecise and evasive language may be a disaster for science but it is a boon in everyday life. ‘I am stressed out’ is non-accusatory, apolitical and detached. It is a good way to keep the peace and, at the same time, a low-cost way to complain.” [109]

The term stress “generally refers to experiences that cause feelings of anxiety and frustration because they push us beyond our ability to successfully cope.” [110] Scientifically, stress has been difficult to define. Different researchers often use different definitions of stress depending on what they’re studying or what field of psychology or science they belong to [111].

In coming chapters I’ll come back to the modern adaptation of Selye’s model of stress, termed “allostatic overload”. But first, I want to look at the basic concepts of stress and its functions in nature.
A BROAD CONCEPT OF STRESS

To gain a better understanding of stress, it’s useful to step away from the medical concept of stress, and think about what the term means in other fields.

When an engineer thinks about stress, it’s usually in relation to a physical force on a material object. As I said before, my son is a Mythbusters fan. He was watching an episode the other day where the Mythbusters were testing the myth of Pykrete, a material that was nothing but wood shavings and ice. They were testing to see whether it was more durable than ice alone, whether it was bulletproof, and whether it could be used to build a boat! [112] In order to test out these crazy claims, they made some in their workshop and compared it with normal ice. How did they test it? By stressing it - placing weights on the end of the block of the ice/pykrete until it broke. (In the end, pykrete was ten times stronger than ice, was bulletproof, and they made a fully operational motor-boat from it!)

So the mechanical definition of stress is, “pressure or tension exerted on a material object.” [3] There are a few illustrations of mechanical stress, in our bodies and in everyday life, that are good metaphors for stress in our lives.

The Classical Stress/Productivity Curve

I confess I am NOT a musician. I’ve never learnt to read music or play an instrument. But I do know that when you first put a new string on the guitar, it’s unstretched – there is literally no force on it at all. If all you did was tied the two ends of the string to the tone peg and the tuning peg, the string would remain limp and lifeless. It wouldn’t be able to do anything useful. It certainly wouldn’t play a note.

When the tuning peg is twisted a few times, there is some tightness in the wire. The string is now under tension (i.e. stress). It is now able to play a note of some form, so it can do some work and fulfill some of the function of a guitar string. But the pitch isn’t good enough - the note is out of tune.

With a small adjustment, the string reaches its optimal tension and can play the correct note! This is the point where the string is fulfilling its designed purpose. Optimal stress equals optimal function.

With further tightening of the string, the perfect pitch is lost, but the string can still produce a sound of some form. With more tension, the string can still make a noise, but it sounds awful, and the fibres inside the cord are starting to tear. If the string were wound further and further, it would eventually break.

If this ratio of the tension of the string versus the usefulness of the string were to be plotted as a graph, it would look like an upside down “U”. This is the classic stress/productivity curve.

The Exponential Stress/Productivity Curve

The second metaphor that I think illustrates a different concept of the stress/productivity relationship is a car.

As well not being a musician, I am also NOT a mechanic! I know the important things like where the petrol goes, and how to drive them, but otherwise cars are very mysterious and powerful devices, their mystery is only exceeded by their power.

What I do know is that the engine is very much like the guitar string. As more petrol is fed into the engine, the engine gets more powerful. Soon, the engine finds its “power band”, a zone of maximum torque that can be achieved at moderate revolutions. As the engine is given more gas, the power output declines from the middle of the power band. If the engine was maxed out then the amount of functional power coming out is reduced.
This would plot as a similar graph to the U-curve of the stress/productivity curve. But cars not only have engines, but also a gearbox. The gears allow for multiplication of the work done (the productivity) for the same stress on the engine.

G-Force!

As a child, I didn’t dream of becoming an astronaut, but I was interested in space. The beauty of our night sky is as stunning as any forest, river or mountain. I would read of the astronauts in rockets and in space stations, floating around in zero gravity, swimming through the “air”. That sounded like a lot of fun.

But zero gravity isn’t particularly good for you. Some early astronauts had to be carried off their landing craft on stretchers because the effect of zero gravity would render these men weak and atrophied. They boarded the spacecraft at the peak of their physical strength and fitness, but after only a few weeks without gravity, their bodies resembled that of the elderly (although without the wrinkles) [113].

It’s a general principle of the human body that any tissue that isn’t needed shrinks in size - a process called atrophy. In zero gravity, the body doesn’t need as much muscle, so the muscles shrink. The body doesn’t need as much bone strength, so the bones weaken. There is no gravity to pull their blood away from their head, so the blood volume decreases. Because there is less muscle to pump blood to, and less blood to pump, the heart doesn’t work as hard, so the heart muscle atrophies. The net effect of zero gravity is to make you physically weak [113].

On the other hand, too much gravity is not great either. Animals can adapt to small amounts of hypergravity [114]. But large amounts aren’t so good. During astronaut training, NASA subjects the rookie spacemen to rigorous tests including placing them in a large centrifuge and spinning it very fast. The result is an increase in the gravitational forces applied to their bodies. The increased gravity makes everything in the body heavier and their blood is pulled towards the legs and away from the brain, which leads to what is known as G-LOC (Gravity-induced Loss Of Consciousness). In other words, the heart can’t fight the increased force of gravity and the brain loses its blood supply, which makes you pass out. Josh McHugh did an entertaining piece on his experience with G-LOC and the centrifuge in Wired (2003) [115].

In this sense, gravity is to us physically like stress is to us mentally. Without gravity, our physical bodies turn to mush as we slowly weaken from the inside. Too much gravity, and our physical bodies are slowly squashed by the invisible weight of the extra G’s. Our bodies work best at 1G.

MECHANICAL STRESS AND YOU

How does all this fit with stress? One of the reasons why gravity gives you strong muscles and bones, and zero gravity gives you weak muscles and bones, is because of resistance.

Movement involves work. We do "work" everyday in simple everyday activities, because our muscles and bones have to apply a certain amount of force in order to overcome gravity. Our muscles adapt by growing the muscle fibres to provide that force, and bones remodel themselves to provide the maximum resistance to the loads that gravity and the muscles put through them. We’re not aware of this day-to-day because we never experience prolonged changes in our gravitational fields.

But when we need to do more work than our muscles are accustomed to, our muscle fibres increase in strength, first as the nerve networks that supply the muscles become more efficient, after about two weeks of ongoing training, the fibres themselves increase in size [116, 117]. The growth in muscle fibres is caused by three related factors: mechanical
tension, muscle damage and metabolic stress [117]. Mechanical tension involves “force generation and stretch”. In other words, the muscle fibres are stretched just beyond their usual capacity, and they actively fight against the resistance. This damages the weaker muscle fibres, which are repaired. The remaining muscle fibres are forced to adapt by growing larger because of the stimulation of growth factors [117].

One of my favorite "Demotivator" posters says, "That which does not kill me postpones the inevitable" [118]. Of course, the phrase that they’ve parodied is, "That which does not kill us makes us stronger." Why is there truth to that idiom? Adversity occurs when life circumstances come against us. In other words, adversity resists us. In the arm wrestle between adversity and overcoming, work is involved. We have to fight back.

In a similar way, we grow when adversity pushes us just beyond what we have done before, stretching us. We may sustain some damage in the process, but that helps to reduce our weaknesses, and forces us into growth as we heal. When we push back against adversity, the “cells” of our character grow.

Of course, we all know examples where muscles fail under intense or prolonged loads. I vividly remember the pictures of the UK’s Paula Radcliffe, succumbing to the grueling hills and scorching Athens heat with only four miles left in the 2004 Olympic Marathon. Muscle failure from excessive stretch or excessive endurance parallels the allostatic load response, which is what people commonly referred to as ‘stress’.

**SCIENTIFIC EVIDENCE THAT STRESS IS POSITIVE**

There have been recent studies in animals that demonstrate that stress is physically as well as mentally enhancing.

Neurogenesis is the process of new nerve cell formation. Studies of rodents placed under intermittent predictable stressors showed an increase in neurogenesis within the hippocampus, which is the part of the brain related to learning and memory. Along with this enhancement of neurogenesis, the function of the hippocampus increased, specifically hippocampal-dependent memory, with a reduction in depression and anxiety-like behaviours.

As Petrik et al noted in their review, “Contrary to stress always being ‘bad’, it has long been appreciated that stress has an important biological role, and recent research supports that some amount of stress at the right time is actually useful for learning and memory.” [119]

**LESSONS FROM STRESS**

So what can we learn from stress? How do we use the stress that we are exposed to every day to make us grow strong and durable?

Firstly, like the guitar string, we need to learn when we are in tune, at the peak of our productivity. Or like the car engine, what it feels like to be in the power band. When we know where our sweet spot is, we can operate within it, achieving our best in life without doing ourselves harm. This is the first point that we need to identify on our own personal stress/productivity curve. This is the point of maximum productivity.

The other life principle to be gained from the car engine analogy is that not all of us are high performance engines. I would love to think that I’m a F1 racing engine - highly tuned, supreme power - but I recognise my limitations. I would even settle for a 5-litre V8, but I know that I’m probably more like a well-tuned V6. We are what we are. Sometimes we apply the most stress to ourselves when we try to drive in the power band of someone else’s engine. We need to accept who we are.

It seems logical that if too much stress is bad for us, then having little or no stress is good for
us. But like the new guitar string, minimal stress makes us unproductive. Like zero gravity on the body, little or no stress makes us weak.

And we need to understand that a bit more stress is ok. It’s inevitable that we are going to be stressed beyond what we usually cope with at times. But without that challenge, there would be no growth. Challenges usually hurt. You can’t have growth without pain. In the muscle analogy, at the stretch at which peak growth occurs, muscle fibres tear and the lactic acid build up in the remaining cells can be very uncomfortable. The key is learning how far we can push ourselves before we start to falter and fail. This is the second point we need to discover on our personal stress/productivity curve. This is the point of maximum growth.

Once we understand our own individual points of maximum productivity and growth, we can use them as guides to our personal growth and achievement. Actually, I should specify that these are our starting points, since as we face challenges and experience growth, the points will change slightly. We can remap those points and continue in our pattern of growth and development.

Pushing ourselves into just enough stress to achieve growth, then pulling back to rest and restore, is a pattern of growth that is seen in many facets of the natural world and the human body. Body builders and athletes use this method all the time in their training. They push themselves with more repetitions and heavier weights, or longer or faster runs, then they pull back to consolidate their gains. During our adolescence, our bodies naturally go through growth spurts - periods of rapid growth followed by a plateau, before the next burst of growth hormone hits us again. Even tree rings demonstrate that growth and consolidation occur all the way through the natural world.

This is the Stressed-Rest cycle. The studies in animals on neurogenesis strengthen the theory, because it was the animals that experienced bursts of stress that showed enhanced neurogenesis, memory and reduced depression/anxiety behaviours.

If you want maximum personal growth, constant stress does not help. There has to be times of rest. Some people think that rest time is wasted time, reducing productivity. But as explained, without rest time, productivity rapidly falls away. Without rest, stress goes bad, leading to allostatic overload.

So in summary, excessive stress is bad. But if all stress were bad, then we would all crumple any time that something became difficult. So stress is not a force for evil. Stress is part of our normal everyday lives, and is vital if we are to see ongoing personal growth.

We know from living life that we all don't fall in a heap when things go wrong. We have in-built ways of coping that help us to absorb troubles and adversities and like emotional photosynthesis - turn them into fuel for growth.

This is the science of resilience, the counterbalance to the forces of stress that help us cope and adapt in a rapidly changing natural and social environment, the Yang to allostatic overload’s Yin. A discussion on the science of stress is not complete without a discussion of resilience, which I’ll discuss now.

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CHAPTER 5 - THE SCIENCE OF RESILIENCE - THE ANTITHESIS TO STRESS

Friedrich Nietzsche, the German philosopher, famously said: "That which does not kill us makes us stronger."

That phrase has become part of our idiom because we intuitively know Nietzsche was right.
We see it every day, from small babies who fall over time and again but who finally learn to walk, all the way through to cultural heroes who either seem to thrive on adversity or who, despite failures, set backs and despair, push through and eventually triumph.

But for every hero who conquers the hardship and heartbreak, there are many other nameless casualties, who suffered the same hardships, the same setbacks, and who sank rather than swam. What is it that separates the nameless casualties from the heroes? Is it a good thought pattern, or is it something deeper? The answer lies in resilience.

**WHAT IS RESILIENCE?**

Resilience is the term given to the individual’s capacity to cope.

Researchers in the field of psychiatry often use the term resilience, which “is the capacity and dynamic process of adaptively overcoming stress and adversity while maintaining normal psychological and physical functioning” [120] although psychologists and social science researchers would use the term “coping”, which is defined by Compas et al as, “conscious and volitional efforts to regulate emotion, cognition, behavior, physiology, and the environment in response to stressful events or circumstances.” [121] Skinner and Zimmer-Gembeck define coping as, “action regulation under stress.” [122]

Considering the definitions used, the terms are essentially interchangeable. The other observation to be made here is that coping/resilience is an active process. It’s not something that happens despite of us - we actively cope with stress. In the face of a situation involving emotional arousal (danger or stress), we take steps to deal with our inner and outer environments (the physiological processes of our body, as well as the environment around us). Sometimes these steps are conscious and/or under our control. But theorists also consider automatic, unconscious, and involuntary responses to also be part of the coping spectrum [123].

**WHAT CONTRIBUTES TO RESILIENCE?**

**Coping Strategies**

What makes up those actions? What influences the action steps?

Psychologists have described hundreds of individual methods of coping through recent research, although there have been efforts to consolidate the plethora of individual coping strategies into “family” clusters, based on function. For example, a primary tier is to “Coordinate actions and contingencies in the environment” which involves “finding additional contingencies” which on the third level involves “reading, observation, and asking others.” [122] Table 1 in the paper by Skinner and Zimmer-Gembeck [122] summarize the many ways of coping and how they can be grouped together into families, and their corresponding adaptive process.

**Personality factors**

Coping strategies follow along the lines of personality type [124], as well as the stage of development in children [122]. Personality types such as Neuroticism and Openness have been well studied, with Neuroticism associated with maladaptive coping strategies, and Openness correlated with adaptive coping (in marital relationships [125] and in public speaking tasks [124]).

Further research has shown how personality significantly influences coping, with the severity of the stress, and the age and culture of a person influencing the strategy and strength of the coping response [123]. Of course, personality traits like neuroticism sound bad, but they confer their own strengths. For example, negative affect has protective benefits by enhancing
the detection of deception [126].

**Biological factors**

The shared connection that personality types and coping responses have is in their shared genetics, with personality and coping styles influenced by common genes [127]. This makes perfect sense as it has been shown that changes in individual genes effect the ability of the brain to associate the correct value to rewards [128], which then influences both mood [11], and learning [129]. Even though environmental variables are important in determining personality and learning aspects of coping with stress, the brains underlying capacity to process the incoming signals correctly will significantly influence the direction and outcome of the learning process, which includes learning which coping strategies work best for each individual.

On a deeper level, there are several biological processes that make up the features of resilience. Animal studies on resilience, as a whole, have shown that resilience "is mediated not only by the absence of key molecular abnormalities that occur in susceptible animals to impair their coping ability, but also by the presence of distinct molecular adaptations that occur specifically in resilient individuals to help promote normal behavioral function.” [130] That is, resilient individuals have the full complement of critical components in the resilience pathway, and have some extra tools too.

Human studies thus far have shown strong links to genetic changes that affect the proteins in the stress system. Epigenetic mechanisms are involved, and the role of the environment is also significant, especially uncontrollable early childhood trauma. Wu et al list the current studies of genetic changes that effect resilience in humans [120: Table 1]. The proteins involved are responsible for the growth of new nerve pathways (BDNF), and for their function, especially within the stress system (CRHR1, FKBP5) and in control of mood and reward systems (COMT, DAT1, DRD2/4, 5-HTTLPR, the HTR group).

Wu et al [120] also summarised the currently known facts about epigenetic factors in resilience. Interestingly, they noted an animal study in which chronic stressors increased an epigenetic marker called histone acetylation in the hippocampus in mice, which enhanced the protective effects of the stress (we’ll further discuss the significance of this in chapter 12).

**Resilience on a personal level**

So coping and resilience are known protective factors for stress, and are more commonly deployed than most people realize. Despite all of the publicity that stress has generated, human beings remain remarkably unscathed. It’s estimated that, “in the general population, between 50 and 60% experience a severe trauma, yet the prevalence of illness is estimated to be only 7.8%.” [130] (Note: By ‘illness’, the authors were referring to Post Traumatic Stress Disorder, not all of human sickness).

But when it comes to recommending different coping strategies on an individual level, it is a much harder thing to do. What is adaptive in some situations and for some people is maladaptive in other situations and for other people.

For example, in animal studies, “stressed females tend to perform better than males on non-aversive cognitive or memory tasks … Conversely, in tests of acute stress or aversive conditioning, stress enhances learning in males and impairs it in females … the literature suggests that in cognitive domains females cope better with chronic forms of stress, whereas males tend to cope better with acute stress.” [130] So animal studies confirm a difference in the biological stress response between men and women. If these studies in animals can be extended to humans, it may explain the tendency for men to engage in “fight-or-fight”
responses to stress where women usually move to “tend-and-befriend” mode [131].

Human studies on coping also demonstrate that what is good for one is not necessarily good for another. Connor-Smith and Flachsbart confirm that, “In particular, daily report and laboratory studies suggest that individuals high in sensitivity to threat may either benefit from disengagement or be harmed by engagement in the short term, with the opposite pattern appearing for individuals low in threat sensitivity.” [123]

So in other words, just because engaging may be a positive method of coping does not mean that it should be recommended to everyone. Some people will have more harm from trying to engage. Care should be taken when giving people advice about how to manage their stress. Ill-informed instructions can actually make things worse.

SUMMARY

It’s well established that stress can have negative impacts on your physical and mental health. But contrary to the popular view, stress is not always bad. As a number of authors point out, most people go through significant stress at some point in their lives, but only a fraction succumb to that stress.

The difference is the factors that make up resilience. Where we are along the stress spectrum (that is, whether you are wired to be more stressed, or more resistant to stress) depends on our genetic predisposition, which determines the physiology of our stress system and our personality, and the ways we learn to cope.

How we cope best depends on our individual traits and the situation. There is no one-size-fits-all. Pushing a person into a form of coping that’s not suitable can actually cause a lot of harm.

Remember, we normally find what coping strategies work for us automatically as our resilience is mostly innate, and we all go through severe stress at some point or another in our lives, but only a small fraction of us will succumb to that stress.

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SECTION 3

REAPPRAISING DR LEAF

CHAPTER 6 – REAPPRAISING DR LEAF

In the first two sections, I outlined the current scientific concepts of thought and stress, and the basic science behind them. In this short chapter, I want to bring everything together.

I will compare the fundamentals of Dr Leaf’s teaching with the current scientific research and models I’ve outlined in the beginning of the book. I will use illustrative quotes from her books to show that I’m not misrepresenting her. Then I’ll discuss what the scientific literature suggests, allowing you to compare them.

In my introduction, I proposed that the fundamental arguments of Dr Leaf’s work are:

* Thought is the main driving force that controls every other aspect of our lives (and our physical world).
* We have full control over our thoughts.
* Thought causes stress.
* Stress is directly responsible for nearly all serious physical and mental illness.

* Since thoughts cause stress, and stress is directly responsible for the vast majority of human disease and suffering, thought therefore causes the vast majority of human disease, making thoughts toxic. If toxic thoughts cause disease, “detoxing” thoughts will cure or prevent disease.

Let’s review these, one by one.

1. **Thought is the main driving force that controls our lives (and our physical world).**

Dr Leaf’s teaching:

“Thoughts influence every decision, word, action and physical reaction we make.” [1: p13]

“Our mind is designed to control the body, of which the brain is a part, not the other way around. Matter does not control us; we control matter through our thinking and choosing.” [2: p33]

“Research shows that 75 to 98 percent of mental, physical, and behavioural illness comes from ones thought life.” [2: p33]

“DNA actually changes shape according to our thoughts.” [2: p35]

“The main point in this chapter is that mind controls matter.” [2: p38]

“It is very interesting that every cell in the body is connected to the heart, and the brain controls the heart, and the mind controls the brain. So whatever you are thinking about affects every cell in our body.” [2: p94]

“Everything you do and say is first a thought in your physical brain. You think, then you do, which cycles back to the original thought, changing it and the thoughts connected to it in a dynamic interrelationship. If your thinking is off … then your communication through what you say and do is off, and vice versa.” [2: p98-9]

“Quantum theory converts science’s conception of humans from being mere cogs in a gigantic, mechanical machine to being freethinking agents whose conscious, free choices affect the physical world.” [2: p120-1]

“Thought signals seem to move faster than the speed of light and in ways that classical physics cannot explain. This means our mind controls matter, and is therefore a creative force.” [2: p121]

The scientific response:

Thoughts do not control our brain, our lives, or physical matter. Thoughts are a function of our physical brain, one small part of our brains overall activity. Thoughts are not faster than light, and they do not control physical matter.

Specifically, thoughts are an explicit (conscious) projection of information, formed as working memory utilizes a larger area of cerebral cortex to process specific parts of a much larger, ongoing stream of information, as directed by the implicit executive systems of our brain. Thoughts are like the image on the monitor on your computer. Billions of calculations are being performed by your computer every second, but all you see of them are what is projected onto your monitor.

Thoughts, and the mind, are a product of the brain. They do not control the brain. Disorders of the brain, such as tumours or infections, confirm the influence of the brain on our thought content. Again using the computer/monitor analogy, the information on the monitor doesn’t control the billions of calculations going on underneath, the billions of calculations controls
what is on the monitor.

Dr Leaf uses the term “thought” to refer to all brain activity, but her definition is so broad that she invalidates her own arguments. The structure of the brain changes during thought, but the structure of the brain changes with all activity of the brain, just like the structure of all tissues changes with its use. Thought is not required for neurological changes to occur.

If thoughts cannot control the brain, then they certainly cannot control any other form of matter. This is intuitively obvious, because you can’t think yourself thinner, think yourself taller, or think yourself younger. You can’t move objects with your mind, change the weather, or change other people. Thought does not control matter.

2. We have full control over our thoughts

Dr Leaf’s teaching:

“We have two choices, we can let our thoughts become toxic and poisonous or we can detox our negative thoughts which will improve our emotional wholeness and even recover our physical health.” [1: p21]

“Free will and choice are real, spiritual and scientific facts.” [2: p25]

“You body is not in control of your mind – your mind is in control of your body.” [2: p25]

“We are not driven by forces beyond our conscious control.” [2: p42]

The scientific response:

Thought is the conscious awareness of a much greater stream of information processing. It is the brain’s working memory engaging a larger area of the cerebral cortex to process more important information. It can appear that we have control of our thought process, because it seems that we can direct our attention to a task or problem. Yet, if we were to have full control over our thoughts, then we could never experience daydreaming, or those “eureka” moments of inspiration, which occur without the control of our attention.

In neurobiological terms, control over our thoughts comes with engaging the central executive network. But the default mode network is not associated with complete control over our stream of thoughts, and since the default mode network is, quite literally, the default mode, it is clearly incorrect to suggest that we have complete control over our thought process.

Similarly, although our actions and our thoughts seem as though they are under our full control, many scientists have shown that free will is an illusion, with experiments showing repeatable and predictable brain activity up to 8 seconds before a person was aware of the choice they would make. And as shown by models like the Cognitive Action Pathways model, there are many variables that feed into our thoughts, such as genetic changes to our perception, our personality, and our physiology. At best, we have partial free will, limited by our genetics and the underlying information processing of our brain.

3. Thought causes stress

Dr Leaf’s teaching:

“The result of toxic thinking translates into stress in your body.” [1: p15]

“Stress is a global term for the extreme strain on your body’s systems as a result of toxic thinking.” [1: p15]

“Stress is a direct result of toxic thinking.” [1: p29]
“These stages of stress are scientifically significant because they illustrate how a single toxic thought causes extreme reactions in so many of our systems.” [1: p39]

“As you think those negative thoughts about the future … that toxic thinking will change your brain wiring in a negative direction and throw your mind and body into stress.” [2: p35]

“This immediately puts the brain into protection mode, and the brain translates these poor-quality, toxic thoughts as negative stress.” [2: p36]

The scientific response:

Stress, as defined by Dr Leaf, is based on Selye’s General Adaptation Syndrome model. Selye developed the General Adaptation Syndrome model based on the response of animals to physiological stressors. He did not subject the animals to psychological stress. So stress is not the direct result of toxic thinking, and ironically, the model of stress that Dr Leaf relies on contradicts her own teaching. Other psychological models such as Dual Systems Model confirm that physiological stress is not thought dependent.

Psychological stress is not usually the result of the thought process either. Conditioned fear occurs when a person or animal learns to associate a stimulus (a place, a smell, a sound, etc) with pain or distress. According to the Dual Systems model, when the same situation is reencountered, the stimulus is processed by deeper brain structures (usually the thalamus), which subconsciously recognises the stimulus, and directly primes the stress system in readiness to respond. Eventually the cerebral cortex catches up, and thinking takes place, reappraising the risk and refining the plan of action. So stress is independent of our stream of thought.

Rather, according to the Cognitive Action Pathways model, the stimuli are perceived, processed through the lens of personality and physiology and then processed by the executive areas of our brain that, if required, broadcast these thoughts into our consciousness. Therefore, stress generates stressful thoughts, not the other way around.

Thoughts are often associated with stress, since the underlying common neurological and physiological processes often coincide, and our memory is designed to link the two. But correlation is not the same as causation.

4. Stress is directly responsible for nearly all serious physical and mental illness.

Dr Leaf’s teaching:

“Hostility and rage are at the top of the list of toxic emotions; they can produce real physiological reactions in the body and cause serious mental and physical illness.” [1: p30]

“Let’s look closely at three systems that are particularly affected by stages two and three of stress: the heart, the immune system, and the digestive system. [1: p39-43]

“Even a little bit of these negative levels of stress from a little bit of toxic thinking has far-reaching consequences for mental and physical health.” [2: p36]

“The association between stress and disease is a colossal 85 percent.” [2: p37]

The scientific response:

Stress is associated with a small number of illnesses, but stress is not associated with the majority of human illness, and even if it were, correlation is not the same as causation. Studies at the coalface of medicine in Australia suggest that presentations for non-physical illnesses (mental health, stress) only amounted to about eight percent of the total number of presentations.
While the majority of the population will at some point suffer an extended period of extreme stress, only a minority will go on to develop a stress related disease.

This is because most people have an inbuilt system of coping, which provides resilience against the effects of stress. Animal models and some human cohort studies have shown that small amounts of stress actually improve function and health.

5. If thoughts cause stress, and stress is directly responsible for nearly all serious physical and mental illness, then thought causes the vast majority of human disease, therefore thoughts can be toxic. If toxic thoughts cause disease, “detoxing” thoughts will cure or prevent disease.

Dr Leaf’s teaching:

“A massive body of research collectively shows that up to 80% of physical, emotional and mental health issues today could be a direct result of our thought lives.” [1: p15]

“Research shows that 75 to 98 percent of mental, physical and behavioural illness comes from one’s thought life.” [2: p33]

“We have two choices, we can let our thoughts become toxic and poisonous or we can detox our negative thoughts which will improve our emotional wholeness and even recover our physical health.” [1: p21]

“Making your thoughts life-giving, not life-threatening, means you will be far less likely to suffer sickness and disease.” [1: p43]

The scientific response:

“Toxic” thought is not the major cause of human disease. Therefore, “detoxing” from negative thoughts does not significantly improve human health.

The major cause of illness across the world is infectious diarrhoeal disease, which is related to clean water and sewerage systems.

In the western world, infectious diseases are limited by our easy access to fresh water and internal plumbing. The techniques and technology of modern medicine, such as public health campaigns for pap smears, modern midwifery, and vaccinations, also prevent many deaths. Cervical cancer, complications of childbirth, and infectious diseases like measles, are not thought related.

Because of the success of modern medicine in treating and preventing these illnesses, chronic diseases, mental health disorders and “stress-related” illnesses have become more prominent, giving the false impression that thought and stress significantly contribute to human health and disease.

Considering health in the overall global context, and by taking into account the effects of medical science on our society, it can be easily seen that thought life could not cause anywhere near 75 percent, let alone 98 percent, of physical and psychological illnesses. The figure proposed by Dr Leaf is therefore grossly exaggerated.

Analysis of the “massive body of research” which Dr Leaf used to arrive at her figure shows that it is based on cherry-picked, out dated and/or non-peer reviewed references.

A full analysis of Dr Leaf’s sources, and the current scientific literature that contradicts her, is documented in Chapter 10.

SUMMARY

So, if thought is not the driving force of our cognition, and thought is not under our full
conscious control, and if thought does not cause stress, and stress does not cause most of the maladies of human kind, then it would be fair to say that even if it were possible to change your thoughts, changing your thoughts would not restore your emotional and physical health. Dr Leaf’s teaching does not align with current scientific knowledge.

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SECTION 4
DR LEAF - ERRATA

CHAPTER 7 - WHAT ELSE DOES DR LEAF SAY ABOUT THOUGHT?

In the first half of the book, I discussed the current scientific understanding of thoughts and stress, and I compared that to Dr Leaf’s fundamental teaching. In this second half of the book, I will be taking a more specific approach, reviewing some of Dr Leaf’s specific statements and contrasting them to current scientific opinion. I do not have space to review all of Dr Leaf’s statements that contradict scientific principles, but I have chosen the most relevant and significant.

The next two chapters deal with Dr Leaf’s descriptions and assertions on thought. In this chapter, I am going to critique some of Dr Leaf’s general statements on thought. In chapter 8, I will review Dr Leaf’s statements specific to “toxic” thoughts.

Dr Leaf describes thoughts as toxic, poisonous, and dangerous. She says, “thoughts are measurable and occupy mental real estate.” She also says “Thoughts influence every decision, word, action and physical reaction we make.” [1: p13] She claims that “A massive body of research collectively shows that up to 80% of physical, emotional and mental health issues today could be a direct result of our thought lives.” [1: p14]

In chapter 2 of her 2009 book, she goes further, “Toxic thoughts are thoughts that trigger negative and anxious emotions, which produce biochemicals that cause the body stress”, and “They are stored in your mind, as well as in the cells in your body.” [1: p19]

And then, “Thoughts are basically electrical impulses, chemicals and neurons. They look like a tree with branches. As the thoughts grow and become permanent, more branches grow and the connections become stronger.” [1: p19] Then in the very next paragraph at the top of page 20 she writes, “As we change our thinking, some branches go away, new ones form, the strength of the connections change, and the memories network with other thoughts.”

Thoughts can’t become permanent, and still be changeable. Which is it? Despite contradicting herself, she doesn’t go on to clarify her statement.

Dr Leaf then goes on, “We have two choices, we can let our thoughts become toxic and poisonous or we can detox our negative thoughts which will improve our emotional wholeness and even recover our physical health.” [1: p21]

She also uses diagrams to further illustrate her explanation of what thoughts are. In her 2009 book [1], on page 14 she illustrates “An Active Thought” showing a schematic diagram of a neuron and a synapse. On page 61, she uses the same picture with the title, “An Active Thought.” On page 20 she has a photograph of a histological section of the cerebral cortex, titled, “Thoughts Grouping Together Like Trees In A Forest - A schematic representation of the Neurons.” On page 30, there is the “Schematic representation of branches (Dendrites) that hold toxic or non toxic thoughts. And on page 33, again she labels a single neuron “A
thought”. She points to the dendrites and comments thus: “tree-like branches where memories are stored.” On the bottom of the diagram she shows two ‘thoughts’ beside each other, one cell flourishing and the other withering, to which she explains: “Dendrites grow extensively on the nerve cell as we think. Dendrites can shrink and fall off with continued high levels of stress.” She also states that, “These toxic thoughts can even look distorted compared to healthy thoughts - chemicals released can even change the shape and even destroy parts of the neurons, causing change right down to the cellular level.” [1: p36]

On page 35, she attempts to demonstrate this in the top photo which, compared to the photo below it, shows the big black hole of “toxic thought” [1: p35]. Except it’s the same photo, but the toxic thought has been made “toxic” by artificially adding a black spot.

So in her 2009 book, Dr Leaf defines thoughts as neurons. She says that the thoughts are stored in the branches of the neurons called dendrites, and if those thoughts are toxic, like stress, the branches will wither away and die.

**INCONSISTENCIES**

“A million to one”

As I outlined early in chapter one, each thought is probably made up of the dynamic interaction of several million neurons and their dendrites. In her first book, Dr Leaf says several times that thoughts just are single neurons and their dendrites, which is incorrect by a factor of several million. In fairness, she did tighten her definition and description in her latest book.

“All your ills”

Dr Leaf makes two different claims about the impact of our thought lives.

On page 15 of “Who Switched Off My Brain”, Dr Leaf made a fairly astounding statement, “A massive body of research collectively shows that up to 80% of physical, emotional and mental health issues today could be a direct result of our thought lives.” [1: p15] That’s a pretty big number! I’m an experienced GP, and compared to what I’ve seen in my office every day for the last ten years, Dr Leaf’s claim seemed extraordinary.

Unfortunately, none of her references listed any quotes or information citing thought as causing 80% of all illness. Indeed, her endnote pointed to a collection of a few peer reviewed articles and official websites. The rest were university links without any data at all, a few books, and a documentary talking about epigenetics. Therefore, her statement that “a massive body of research” documented the relationship of thought and disease is an exaggeration.

She updated the statement in her 2013 book, “Switch On Your Brain”, but exaggerated the number even more [2: p36-8]. In chapter 10, I will show that the “evidence” she cites for this bizarre exaggeration do not support it, and are contrary to current scientific evidence.

From an independent perspective, it’s hard to see where she originally acquired such a large number. Perhaps she arrived at the statement by incorrectly extrapolating a quote from one of her main source websites. Dr Paul Rosch, M.D., President of the American Institute of Stress, said, "75 to 90% of all visits to primary care physicians result from stress-related disorders." [132]

Even then, research disagrees. The BEACH study is an on-going survey, which provides information into the demographics and clinical statistics of patient presentations to Australian General Practice. The BEACH data shows a total of about eight percent of presentations relate to stress and other mental health disorders [133], so unless the US population is radically different to Australia, Dr Rosch’s assertion is still overblown by nearly a factor of
So then, it appears that one of Dr Leaf’s key tenets is nothing more than a misattribution of an exaggeration. There is so much more to disease than stress or thought, and I’ll discuss this fully in chapter 10.

“The line up”

Dr Leaf believes that the neuron of a toxic thought appears different to the neuron of a healthy thought. At best, this is extremely liberal poetic license.

As we discussed earlier, no single nerve cell is responsible for holding a thought. Thoughts depend on the interaction of multiple neural networks, which in turn are made up of multiple nerve pathways involving millions of different nerve cells.

The nerve cells don’t know what they’re actually encoding; they just form the code utilised the nervous system, the neural equivalent to binary code used by a computer. You may have a music file of Mozart and a music file of One Direction. The computer doesn’t know that one file is a thing of beauty, while the other is a travesty of music. It just reads the code. In the same way, the pattern of synapses between the nerve cells simply encodes information. Thought itself can’t cause the cells to wither or die.

“The mystery of the missing memories and deciduous dendrites”

She also states that under stress, memories shrink, like the mental block that one may experience going into an exam. She goes on to state that, “Once your body is truly in stress mode and the cortisol is flowing, dendrites start shrinking and even ‘falling off’” [1: p32]. Do your memories go missing? Do the dendrites of nerve cells shake and fall like tree branches in a storm? No, on both counts.

This phenomenon of mental block under high stress was first proposed in 1908 and is currently known as the Yerkes-Dodson Law, a fundamental principle of the behavioural sciences [134]. Similar to the stress-productivity curve, Yerkes and Dodson proposed a U-shaped curve to represent the relationship between arousal (which could be either level of consciousness or stress) and behavioural performance. At low arousal, there is poor performance. At the mid-point of arousal, there is peak performance, and at high arousal, performance diminishes.

When faced with a high level of acute stress, the brain switches into a binary mode - fight/flight or freeze. Imagine walking along a path in a forest and you see a snake, only inches in front of you on the path. Self-preservation has to kick in. The only decision you have to make then and there is whether to run, to try and kill the snake before it kills you, or stop dead still and hope that the snake ignores you and slithers away.

At that point, most memory is redundant, as is a high-level analysis of snake species, or any other cognitive pursuit. The brain doesn’t need them at that precise moment, and if they did engage, they would just get in the way. Switching the thinking parts of your brain off focuses your attention on the immediate danger. It is an adaptive survival response. Meantime, your memories and your theoretical knowledge about snakes don’t disappear. They are still there, unchanged. It is false to suggest that the memories “shrink”.

Dr Leaf also attempts to use her “neurons as trees” analogy to describe a process where the dendrites of a neuron shrink back under certain conditions. But neurons are not trees and dendrites are not tree branches. The dendrites do not ‘fall off’ the neuron. The neurons in the brain have mechanisms for ongoing brain plasticity - the ability of the brain to adapt to the challenges and changes in its internal and external environment that are constantly occurring.
If the brain needs to build a new circuit to encode a new piece of information, then it grows new dendrites and creates new synapses. But the brain is limited by the amount of energy it can consume, and therefore the number of synapses it can maintain. So the brain trims unnecessary dendrites, a process called “synaptic pruning”.

Synaptic pruning is a normal process. Chechik and Meilijson confirm that, “Human and animal studies show that mammalian brains undergoes massive synaptic pruning during childhood, removing about half of the synapses until puberty.” [135]

Synaptic pruning is not deleterious, but beneficial. Chechik and Meilijson also note that, “synaptic overgrowth followed by judicial pruning along development improves the performance of an associative memory network with limited synaptic resources.” [135] So synaptic pruning is a normal physiological process, and occurs in all of us for many reasons, predominantly to improve the efficiency of our neural networks. Perhaps synaptic pruning associated with the stress response is also an adaptive process?

Synaptic pruning also occurs in other physiological states that have nothing to do with stress or thought, such as the effects of oestrogen during the menstrual cycle and at menopause [136, 137].

It should also be noted that the link between stress and dendrite loss is not consistent. Some authors like Kopp and Rethelyi suggest that “severe stress for a prolonged period causes damage in hippocampal pyramidal neurons, especially in the CA3 and CA4 region and reductions in the length and arborization of their dendrites.” [138] However, Chen et al writes, “Whereas hippocampus-mediated memory deficits commonly were associated with—and perhaps result from—loss of synapse-bearing dendrites and dendritic spines, this association has not been universal so that the structure–function relationship underlying the effects of stress on hippocampal neurons has not been resolved.” [139]

It’s more accurate to think that chronic stress causes dendritic remodeling in animals [140], in which some nerve cells prune their synapses, while others grow them, and energy is diverted away from new nerve cell formation to the new synapses that are needed to cope with the stress.

In keeping with this explanation, there is decreased hippocampal cell proliferation during or immediately after stress but no change in survival of the cells that were dividing prior to stress [141]. That is, stress reduced the new cell formation, but the other cells did not die. In addition, decreased new nerve cell growth is thought to result in decreased hippocampal volume, although several studies showed there was no change in the thickness of the main (granule) cell layer volume reported in many stress studies [142-144].

To add to the mixing pot of new discovery, there are a few recent studies that suggest stress does not decrease neurogenesis but actually can increase neurogenesis, and that this increase is functionally relevant [145-147]. Finally, many studies show that stress-induced decreases in one measurement of neurogenesis did not correlate with depressed or anxious traits [148].

In human depression, reduction in the size of the hippocampus is related to the loss of the surrounding glial cells, and not necessarily to changes in the nerve cells [140]. There may also be some reduction in the number of synapses within the hippocampus and the frontal lobes of the brain, which may account for the change in size observed by a number of researchers. But the modern thinking on these changes is that they are ASSOCIATED with depression, NOT CAUSED BY depression [149] (remember, correlation does not equal causation).

We know that stress is associated with depression, but this is because genetic defects in one or
multiple genes reduce the ability for the brain cells to produce synaptic branches. It is this decrease in the number of synapses that contributes to the typical changes in the brain seen at autopsy [150]. The reduced ability of the nerve cells to grow synapses means that new branches can’t grow fast enough to process the stress signals properly [130, 150]. The poor signal transmission leads to both a predisposition towards mood disorders like anxiety and depression [11, 149-152]. Less synaptic branches mean both a smaller volume of the hippocampus, and an inability to process stress signals leads to a larger, overactive amygdala.

In summary, synaptic pruning is not due to toxic thinking. It’s a normal process that takes place to make the synaptic network more efficient, and occurs in stress, but also in the maturation into adolescence, menopause and the menstrual cycle. Stress doesn’t cause dendrites to fall off, but causes a reorganization of the dendrites to adapt to the new signals. In those people prone to depression, the underlying genetic changes in the proteins that enable nerve cells to grow branches increases vulnerability to stress. This is why stress is associated with depression, but does not cause depression.

“Thoughts are real, take up mental real estate, and have a photocopy stored in the cells of the body”.

Dr Leaf states that, “Thoughts are real, physical things that occupy mental real estate.” [2: p32]

No one’s denying that thoughts are real. The key issue is not whether thoughts are real, but what thoughts really are. In the same way that a projection on a movie screen is a real series of images of a historical or fictional event, so thoughts are a real projection of the information from the deeper information stream within the brain. Just because thoughts are real doesn’t mean they’re pre-eminent.

In her first book, Dr Leaf suggested that thoughts were measurable [1: p13]. Technically speaking, brain activity can be measured, of which thought is just one form. There are parts of the brain that are involved in the processing of signals of the working memory slave systems that provide the stream of thought. So, sure, thoughts occupy some ‘real estate’ in the brain.

However, the claim that these thoughts or memories are also stored as photocopies in the other cells in your body is incorrect. That theory is the concepts of epigenetics taken to an extreme. More will be discussed in the chapter on Epigenetics.

“The Geodesic Information Processing Model” and Dr Leaf’s other published research

Dr Leaf proposed the Geodesic Information Processing model in a PhD thesis in 1997. PhD’s don’t just grow on trees. They take years of hard work and dedication, and Dr Leaf deserves credit for earning hers. According to her CV, Dr Leaf developed the Mind-Mapping Approach and the Metacognitive Map based on her PhD research [153].

Dr Leaf writes very highly of her own work, describing in her 2013 book how she abandoned traditional therapy and “trained (my patients) in a new technique I had developed” (the MMA, or the Mind Mapping Approach, which she didn’t develop herself, but borrowed from a British psychologist, Tony Buzan [154, 155]).

She goes on, “The changes were almost immediate: Improved focus, concentration, understanding, shifting efficiency, and overall effectiveness in producing positive work. There were even positive emotional changes, specifically in self-motivation and self-esteem … In the ensuing past twenty years, I have seen these improvements in thousands of patients and clients.” [2: p98]
Later in the book, Dr Leaf states that, “My patients with closed-head injuries showed between 110 to 140 percent increase in their academic results … not only did it improve academic function, but intellectual, emotional and social skills showed dramatic change as well.” [2: p142]

A few general observations first, before I discuss the specifics of her research findings. It should be noted that Dr Leaf’s model focused on the application of mind-mapping in a learning context, specifically, primary school education, not to thought in general. Secondly, her Masters thesis and her PhD thesis were never published in peer-reviewed journals (which means that they missed out on broader critical review from the scientific community).

It should also be noted that in the twenty years since she published her first article, no one else has cited her.

That finding surprised me, since Dr Leaf often boasts over the application of her research to dramatically lift the pass rate of underprivileged students in the South African education system [Dr Leaf’s CV: 153], and of the thousands of patients that have benefited from her methods [2: p142].

Does Dr Leaf’s published research support her claims? For example, does she have documented results that show her patients had a 110 to 140 percent increase in their academic results? I haven’t found any evidence that verifies her statement.

According to her 1993 paper published in The South African Journal of Communication Disorders, her Masters thesis was based on the application of the Mind-Mapping Approach to a single patient [156]. There is no mention of other patients being involved in the research, or of any control groups to provide robust statistical analysis, in any of her three papers listed on PubMed** [156-158]. There was certainly no mention of the percentage improvement of this patient within the journal articles. Perhaps Dr Leaf can provide independently verified evidence for her statement, but there is none readily available to confirm it.

Even if the figures of 110 to 140 percent were accurate, such results aren’t that spectacular. The language is misleading, but a “110 percent improvement” means “the old score, plus 10 percent”, and “140 percent improvement” means “the old score, plus 40 percent.” The average placebo effect is around 30 percent (“a 130 percent improvement”), so it’s entirely possible that the increase in scores were simply due to chance or a general treatment effect, and not the mind-mapping approach that she used. Dr Leaf admitted this herself in her original article [156].

Dr Leaf officially published her Geodesic Information Processing Model in a journal article in 1997 [157]. Overall, I admit that I liked Dr Leaf’s 1997 paper. There were a number of points that I think were, and probably still are applicable to learning within the school environment. However, the Geodesic Information Processing Model itself has a number of fundamental flaws. It assumes that non-conscious brain activity is equivalent to thought, which weakens its theoretical basis, since as we know from section one, not all brain activity is thought, or even accessible to thought. The model was developed as a model of learning in an educational context, and since learning and thought are different processes, Dr Leaf’s model cannot be directly applied to thought [157].

It also puts reading and “reception” into the output side of the model [2: p126-7, 157], which is confusing since they are sensory, or input, processes. Dr Leaf also says that, “The symbolic action level incorporates the five senses through which you express yourself and experience the world, serving as the contact between the external world and the internal world of your mind.” [2: p125&128] That’s also confusing, since we do not express ourselves through our senses, but through behaviour/action.
She explains that, “this model works in reverse as well, forming a perfect circle. So information comes through the five senses, is received consciously by the conscious cognitive level, and then passes into the nonconscious metacognitive level where - if you have paid attention and started thinking and choosing - it becomes a physical thought as a result of genetic expression.” [2: p128] Later in the book she clarifies that the part of the brain that allegedly passes the information from the five senses to the rest of the brain is the thalamus [2: p165].

It may seem trivial, but the sense of smell bypasses the thalamus almost entirely [159], something that a cognitive neuroscientist would have known or discovered in their research. The data streams from the other four senses are processed by the thalamus, which is non-conscious. The information is sorted and passed to specific areas within the cerebral cortex, either to be discarded if it’s not salient, or processed by the executive areas of the brain in a non-conscious information stream, and only processed in our conscious working memory if required [20]. Most of the sensory information that we perceive will never reach our consciousness, because it’s unnecessary, and our brain has limited processing power available [160]. Thus, the information is not “sensory -> conscious -> unconscious”, but “sensory -> unconscious +/- conscious”. Dr Leaf has the process backwards.

**Does cognitive therapy really help?**

If Dr Leaf was correct in her proposal that thought is responsible for the state of our mental health, then therapies specifically aimed at fixing thought would improve psychological problems.

But when examined scientifically, the opposite is true. That is, cognitive therapy specifically targeting problem thoughts offers no extra improvement over behavioural therapy alone. Herbert and Forman confirm this when they point out that, “proponents of behavioral activation point to the results of component control studies of CT, in which behavioral activation or exposure alone is compared to behavioral activation (or exposure) plus cognitive restructuring. The majority of these studies have failed to demonstrate incremental effects of cognitive restructuring strategies.” [161]

This fact has been further confirmed by a number of meta-analyses [101] and by a large randomised controlled trial comparing behavioural therapy and cognitive therapy side by side with medication for depression [102].

So therapies aimed at fixing thinking works equally as well as therapies aimed only at promoting therapeutic action. However, when thinking therapies are added to behaviour therapies, they add no extra benefit over and above the behaviour therapies alone [101]. This suggests that action is the driver of the therapeutic effects of psychological therapy. If thinking were the driving force of psychological change, the addition of cognitive therapy to behaviour therapy should have an incremental effect.

That cognitive therapy works equally well as behavioural therapy may be related to their fundamental similarities. Dobson et al explains, “Behavioural Activation is implemented in a manner that is intended to both teach coping skills and to reduce future risk. The same is true for Cognitive Therapy, which adds an emphasis on cognitive change, but otherwise takes a similar skills-training approach.” [102] In other words, cognitive therapy is just behavioural therapy with bling.

Herbert and Forman summarise it nicely, “The ideas that thoughts and beliefs lead directly to feelings and behavior, and that to change one’s maladaptive behavior and subjective sense of well-being one must first change one’s cognitions, are central themes of Western folk psychology. We encourage friends to “look on the bright side” of difficult situations in order
to improve their distress. We seek to cultivate “positive attitudes” in our children in the belief that this will lead to better academic or athletic performance. Traditional cognitively-oriented models of CBT (e.g., CT, stress inoculation training, and rational emotive behavior therapy) build on these culturally sanctioned ideas by describing causal effects of cognitions on affect and behavior, and by interventions targeting distorted, dysfunctional, or otherwise maladaptive cognitions.” [161]

I understand that many people will find this hard to accept. We’re encouraged to think positive so often that it becomes a self-perpetuating cliché. There can also be confusion around some of the semantics. Many psychologists think of cognition as more than just thought, and newer psychological therapies like ACT seem to emphasise the cognitive as well as the behavioural.

It’s true that the first step in ACT is to defuse from our thoughts, although this isn’t changing our thoughts as per classical CBT (and repeated by Dr Leaf), but rather ignoring them so that meaningful action can then take place. Depending on the therapy, and the definitions used, some may argue that successful therapy has a “cognitive” component, but semantic squabbling aside, the fundamental pillar of CBT/Dr Leaf - that psychological therapy begins with fixing problem thoughts - is outdated.

As noted by Harris, “If you look through the wide variety of writings on ACT, you will find over a hundred different cognitive defusion techniques. For example, to deal with an unpleasant thought, we might simply observe it with detachment; or repeat it over and over, out aloud, until it just becomes a meaningless sound; or imagine it in the voice of a cartoon character; or sing it to the tune of ‘Happy Birthday’; or silently say ‘Thanks, mind’ in gratitude for such an interesting thought. There is endless room for creativity. In contrast to CBT, not one of these cognitive defusion techniques involves evaluating or disputing unwanted thoughts.” [33]

Thus we improve our psychological health through action rather than fixing thought, although sometimes we need to stop fighting with our thoughts and give them some space first. This has been proven in multiple research studies, and by the success of therapies such as ACT, which do not rely on evaluating, disputing or trying to fix unwanted thoughts to achieve their results. Experts in psychological science confirm that Dr Leaf’s central teaching, that we have to change our thoughts to fix our behaviour, is nothing more than culturally sanctioned folklore.

**SUMMARY**

Central to Dr Leaf’s teaching is her insistence that we need to change our thoughts in order to live a healthy and fulfilling life, but this is not what science tells us. Dr Leaf’s teachings are the psychological equivalent of popular mythology.

Dr Leaf’s definition of thought is so broad as to be useless, and her explanation of the effects of stress and “toxic thought” on our brain cells is inconsistent with modern scientific understanding. This is, in part, because Dr Leaf’s based her theories on her PhD research which was also fundamentally flawed, and contrary to her self-promotion, her work has not been cited by any independent researcher. But there are a number of other ways in which Dr Leaf’s concept of toxic thoughts does not match scientific evidence or common sense, and that’s what we will discuss in the next chapter.

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**CHAPTER 8 - “TOXIC” THOUGHTS**
Toxins! They’re everywhere!

The notion of “toxins” has been increasing for a while, in part because of the power of mass marketing and the celebrity effect. It didn’t take a lot of research to find a myriad of health websites warning of the dangers of hidden harmful substances everywhere: your soup bowl, your sofa, your shower curtain, cookware. Apparently light is even a toxin! [162]

Yet if you ask someone what toxins are, no one can really tell you. “They’re there in our food, and our air, and … ah … and they must be bad, because … well … they’re toxins.” So “toxins” has become a catch-all description of those things inside us that are somehow bad, even if no one knows what they are or what they do to us. And because they are so nebulous, they get blamed for every symptom we can’t otherwise put our finger on.

Of course, if there are “toxins” in our bodies, then we must need products to help us rid our bodies from them. Never mind that our liver and kidney’s already detoxify the substances we consume, and there’s no scientific proof to support detoxing [163]. Never let the truth get in the way of good marketing.

One of Dr Leaf’s central arguments is that thought can be toxic. She said, “Toxic thoughts are thoughts that trigger negative and anxious emotions, which produce biochemicals that cause the body stress.” [1: p19] In order for something to be toxic, it has to be poisonous. “Poisonous” implies that something is capable of producing death or illness if taken into the body.

Are our thoughts capable of producing death or illness?

In this chapter, I want to discuss Dr Leaf’s core argument in more detail, review the statements she makes about toxic thoughts, and discuss why the popular notion of toxins, and Dr Leaf’s notion of toxic thoughts, are both unscientific.

“NEGATIVE” THOUGHTS ARE A SYMPTOM NOT A CAUSE

Remember the last time you had a cold? Was your sore throat or runny nose the cause of the cold, or just symptoms? Clearly, the runny nose and sore throat are just symptoms – sensations of the illness that you are aware of. The actual cause is usually a virus, which you wouldn’t be able to detect unless you had a spare electron microscope laying around.

Thought is a projection of information from the deeper systems in the brain, specifically designed to process the data more efficiently. As shown by the CAP model, there are many different components that feed up into thought. Thought doesn’t drive our brain - our brain drives our thoughts. Since the brain drives our thoughts, our thoughts cannot do anything that the brain has not allowed. If our thoughts aren’t right, it’s the brain that is the underlying issue.

For example, anxiety and other mood disorders may result in unwelcome, unpleasant thoughts. But they occur because of a strong genetic pre-disposition that has been primed, resulting in a much stronger physiological response, and often coupled with personality vulnerabilities and abnormalities of perception. Abnormal thoughts are the result of these factors, not the cause of them.

Consider it from a different angle. If thoughts were truly the source of our mental health problems, then purely cognitive therapies would have a much greater impact on the treatment of these disorders than either medications or purely behavioural therapies. But as we’ve discussed in chapter 7, when cognitive therapies are added to behavioural therapies, there is no incremental benefit [101], and pharmaceuticals are as beneficial as cognitive therapies in most mental health disorders [102].
In research work that has intentionally studied thought separately to stress, thought has not been associated with any significant changes in stress or health behaviour. A study of college students in the US showed no correlation between “negative” thoughts, life stress and health behaviour [164]. It has also been confirmed that thought alone does not lead to detrimental biological changes, such as significant changes in immune function [165].

So thought does not significantly contribute to our mental or physical health. Rather, dysphoric thoughts are the eventual outcome of any number of dysfunctional inputs or process steps in the neuropsychological chain, just as a sore throat is a symptom of an underlying viral infection, not the cause of it.

WHY “TOXIC THOUGHTS” ARE UNSCIENTIFIC

So considering thought in its appropriate context already shows that the idea of “toxic” thoughts is incompatible with modern science. In order to bolster the concept of “toxic” thoughts, Dr Leaf has to reinterpret or ignore various psychological, neuroscientific, and theological facts. When re-examined, these facts confirm that “toxic” thoughts are unscientific and unscriptural.

“Toxic” thoughts are actually beneficial

According to Dr Leaf’s definition, “Toxic thoughts are thoughts that trigger negative and anxious emotions, which produce biochemicals that cause the body stress.” [1: p19] In other words, thoughts that cause stress, as well as anxiety and other “negative” emotions, are always detrimental.

In chapter 4, we discussed the stress-productivity curve and the Yerkes-Dodson Law. According to these two pillars of psychological science, there is a power band in which we work our best when we are under a balanced influence of stress. This is where we all are during the course of our usual daily lives. Stress is generally adaptive - it confers a survival advantage. Why else would God have given it to us in the first place?

A stress response can be seen in people who are mentally preparing for any significant mental or physical task. A recent study suggests that release of cortisol (a stress hormone) in moderate amounts actually improves memory recall [166]. “Anxious emotions”, such as fear, or “negative” emotions, such as anger, also provide a survival advantage. Without appropriate fear, we would not recognize danger signals. Without anger, we would not have the motivation to overcome some obstacles or communicate that intention.

As Skinner and Zimmer-Gembeck observe, “adaptive coping does not rely exclusively on positive emotions nor on constant dampening of an emotional reaction … Adaptive coping profits from flexible access to a range of genuine emotions as well as the ongoing cooperation of emotions with other components of the action system.” [122]

So, if Dr Leaf’s definition is correct, then adaptive survival responses are “toxic”. Common sense tells us that this is not true.

“Causes of stress”

Hans Selye said about stress, “Everybody knows what stress is, but no one really knows.” [105] That’s because everyone suffers from stress at some point, but the causes of stress are as unique as each individual that is affected by it.

What’s clear is that thought does not cause stress, but is a symptom. “Stressed” thoughts may appear as a result of being stressed, but they are not the cause of the stress, any more than a sore throat is the cause of a viral infection.

Science shows that stress generation is predominantly genetic. Some independent sources of
stress affect everyone at some stage (bereavement, natural disasters, job losses, relationship break downs). But the people that are affected the most by stress not only handle all stress poorly because of genetic changes (5-HTTLPR gene polymorphisms) [10, 167], but are also genetically wired to significantly contribute to their own stress. These unintentional, self-generated episodes of stress are called dependent stressful life events (dSLE’s for short). Studies confirm that dSLE’s are strongly genetically influenced [120, 168]. It’s true that cognitive styles (how we process information that we receive from our environment) are influential in the development of stress. Studies link the “negative inferential styles” form of cognitive processing to levels of stress. But again, genetics play a strong role in our personality and resilience [120, 123, 127].

“The high road and the low road”

Anxious and negative emotions aren’t driven by thought, let alone “toxic” thought. According to the Dual Processing model, the brain has two pathways that it processes information via. The first path involves the incoming signals passing into the thalamus deep in the brain, which provides a rough analysis as to what the stimulus might be, while the amygdala codes whether it is dangerous or pleasant. The thalamus acts on this rough, rapid analysis to form a rough, rapid action response. In the case of fear, it primes or drives our system to “flight/flight or freeze”.

The second pathway involves the signal moving up through to the cerebral cortex where the executive parts of our brain have a chance to process the information in a finer, more detailed way, sometimes using conscious broadcast.

Our feelings often act without our awareness or control. Anger often seems to bubble up from the internal depths of our limbic system, and in someone who is already primed, it doesn’t take much for the primeval anger to explode. Then the cerebral cortex has to try and catch up. Fear is the same. I’m not a fan of practical jokes, but I have seen enough TV footage of people being punk’d to know that if you brush an unsuspecting victim’s shoulder with something resembling a tarantula, they don’t relax! They jump, scream, punch, scratch or run first, and only stop a couple of seconds later when their cerebral cortex catches up.

I have a personal rule for my practice: never have friends as patients or patients as friends. I made this rule after some friends bought their one-year-old daughter in to see me for her vaccinations. I did the usual doctor things and gave her the needles, and as expected she was pretty cranky. One week later the same friends invited me to the same child’s one-year birthday party. From thirty meters away, the child saw me and screamed, and hid behind her mother. Now, one year olds don’t have thoughts in the same way we do. Their frontal lobe is still only beginning its development and they are still more reflexive than cognitive. The fact that she screamed and hid in fear had nothing to do with cognitive thought, and all to do with pure limbic associative learning! Fear is not thought driven.

Another observation that supports that stress is not thought-driven is white coat hypertension. Most patients walk into my office perfectly calm. For some people, when they test their blood pressure at home in their lounge chair, it's fine. But then when I test it, it’s sky high. If thought was required to trigger a stress response then these people should have a normal blood pressure, since they are not thinking negative or toxic thoughts. They are sitting in the chair in front of me, relaxed. I’m not so scary that they become fearful of me. When I ask them how they’re feeling, they say they don’t feel stressed in any way. So their stress response is independent of their conscious thought. The situational trigger of being near a doctor has, via the "low road", primed them for fight or flight, independently of the "high road" of the conscious processing from their cerebral cortex.
So the Dual Systems model and the Cognitive-Action Pathways model demonstrate that there are two separate pathways for information processing, evident in fear responses, anger responses, and in medical conditions such as white coat hypertension. The low road bypasses the cerebral cortex entirely, so anxiety, stress and anger responses cannot be solely generated by thoughts as Dr Leaf suggested.

THE MIND-BRAIN LINK

In chapter 1 of her new book, Dr Leaf states that, “Our mind is designed to control the body, of which the brain is a part, not the other way around.” [2: p33] Her statement is in conflict with basic medical science.

The brain controls the mind because drugs, and metabolic disorders that all act on the brain have been proven to change peoples thought patterns. For example, medications for mood disorders act on the neurotransmitter levels within the brain, and on synaptic growth factors [140]. Yet they have been shown over and over again to improve mood and the pattern of thoughts that brains generate [169-171]. Similarly, recent research to show that medications have been shown to improve the extinction of fear in anxiety disorders such as panic disorder, OCD, Social Anxiety Disorder, and PTSD [172].

Injuries or lesions to the brain can also cause changes to the mood, personality or thought pattern of the afflicted patients. One of the most famous examples was the case of Phineas Gage, who accidentally blasted a foot-long steel rod through his skull in 1848, severely damaging the left frontal lobe of his brain. History records that his personality changed from polite, well mannered, and well spoken to fitful, irreverent, impatient of restraint or advice, obstinate and capricious [173]. Injuries and lesions of the parietal lobe of the brain changes the way people see their own bodies. Baars writes, “Patients suffering from right parietal neglect can have disturbing alien experiences of their own bodies, especially of the left arm and leg. Such patients sometimes believe that their left leg belongs to someone else (often a relative), and can desperately try to throw it out of bed. Thus, parietal regions seem to shape contextually both the experience of the visual world and of one’s own body.” [20]

Surgery to the frontal lobe had the same result on mood and cognition. Fumagalli and Priori note that “in 1942 Walter Freeman reported the results for 200 lobotomy cases and acknowledged that the procedure was not always benign: 14% of the patients who underwent prefrontal lobectomy subsequently manifested seizures and impaired cognition, affect, mood and social behaviour.” [173]

So medical science clearly shows that the brain drives thoughts, and Dr Leaf’s suggestion that the mind controls the brain is not supported by basic neurobiology.

CHOICE AND FREE WILL

In chapter 2 of her 2013 work, Dr Leaf argues that every choice we make is completely under our conscious control, and that “our free will influences our thinking which determines our state of mind.” [2: p41]

This is in direct disagreement with cognitive neuroscience. As Leisman notes, “Surprisingly, recent research suggests that conscious choice plays a smaller role in our actions than most people assume. In particular, it (conscious choice) often comes after brain activity that initiates bodily movements, and many researchers conclude that the conscious choice does not cause the movement.” [160] Ellerton, a lecturer in Critical Thinking at the University of Queensland, noted in a piece for the academic blog, The Conversation, “We like to think that we reach conclusions by reviewing facts, weighing evidence and analysing arguments. But this is not how humans usually operate, particularly when decisions are important or need to
be made quickly. What we usually do is arrive at a conclusion independently of conscious reasoning and then, and only if required, search for reasons as to why we might be right.” [174]

The Oracle explained it to Neo, “… you didn't come here to make the choice. You've already made it. You're here to try to understand why you made it.” (Matrix Reloaded, 2003)

Ironically, most of Dr Leaf’s background explanation of her statement is fairly accurate – she discusses the implicit processes of the brain before the broadcast of thought into consciousness, and the human capacity of “awareness of awareness”, that we can observe our own thought. She calls this the “Multiple-Perspective Advantage”, although it’s just the long-recognised principle of metacognition, regifted.

Her statement that “free will” strongly influences us is incorrect, because she does not consider specific neurological conditions defined by movements that are involuntary, and she mislabels any neurological activity as thought.

Medical science has documented a number of disorders demonstrating complex motor patterns and speech occurring without the brains conscious awareness. The Alien Hand Syndrome is a syndrome in which certain lesions in the brain cause one of the patients hands to perform actions separate to the patients wishes [175]. Wegner describes two such patients, a lady whose “left hand would tenaciously grope for and grasp any nearby object, pick and pull at her clothes, and even grasp her throat during sleep … She slept with the arm tied to prevent nocturnal misbehavior”, and a man who, “While playing checkers on one occasion, the left hand made a move he did not wish to make, and he corrected the move with the right hand; however, the left hand, to the patient’s frustration, repeated the false move. On other occasions, he turned the pages of the book with one hand while the other tried to close it; he shaved with the right hand while the left one unzipped his jacket”. [176] The patient does not consciously will the “alien hand” to move, in fact, the “alien hand” often acts against the person’s will, but they’re meaningful actions, not random movements. Similarly, Tourette’s syndrome involves involuntary motor movements, vocalisations and sometimes speech [177]. As we discussed earlier, parasomnias can be quite complex behaviours, all occurring during sleep, without conscious control [178].

There’s obviously a separate system that acts outside of our conscious will. If it’s true that not all sensory input leads to conscious awareness, then it’s equally true that there are actions that do not engage our conscious awareness, and the Alien Hand Syndrome suggests an entirely plausible mechanism.

Her other error comes in her definition of thought. She defines all brain activity as thoughts, including all unconscious brain activity. Her assumption is that all of the implicit, uncontrolled, unconscious brain activity leading to our current choice is the result of all the previous choices over time that we did have control over. “As you think, you are making your way to a decision of some kind, whether it’s as simple as what to eat or as complex as choosing one of several different courses of action you face.” [2: p46]

However, the implicit neurological activity that preceded an action is not just defined by our past choices, but by many other things beyond our control – our environment, our genes, and our reinterpretation of our memories, which as we have discussed, is not a precise recall of our past but an imprecise blend of our overall experience.

Further, we know that thought is dependent on implicit activity of our brains. If I ask you what is 2 x 2, the answer will invariably pop into your head without any thought as to how the answer was formed. Decision-making is the same. Even before an action is taken, the brain has already reviewed a number of possible scenarios and through a competitive process,
created a short list based on needs and pre-emptive rewards, and usually primed our brains motor areas in readiness for the final action to be taken. So our unconscious neurological activity has already limited the choices we find projected into our consciousness.

If all choices are preceded by implicit neurological activity that we can’t control, then that choice isn’t truly free. How then can we have “free will”? Wegner noted the same, “If we put in a module (in a hypothetical artificial brain) that creates actions out of any sort of past experiences or memories, that fashions choices from habits or attitudes or inherited tendencies, we do not get freedom, we get determinism.” [176]

At best, we have constrained freedom of choice – choices limited by the bounds of our consciousness and the components of it. This is exactly what experts in this field, such as Wegner [176] and Bonn [15] propose, and what I have discussed in relation to the Cognitive-Action Pathways model.

Dr Leaf writes that the thinking we do causes biological changes in our brains. I’m not sure how valid her list is on the top of page 47 [2], but even if it’s water tight, the same biological changes occur with any neurological activity, whether intentional or not. Seizures, for example, cause widespread electro-chemical and magnetic changes, but they’re not a form of thinking, and they are certainly not under our direct control. The brain of a foetus does not have the capacity for conscious thought in the same way that adults do, but the foetal brain is undergoing some of the most rapid neurological activity and growth that a person will ever have. Thus, it’s incorrect to claim that choice and free will is the sole cause of physical and chemical changes to our brain.

She then suggests that our choices are the key initiator of the gene switches that wire our thoughts into our brains, because our choices influence epigenetics, which then starts the process of gene expression. We’ll discuss this more in chapter 12, but suffice to say, epigenetics has only a small role in gene expression, and thought has nothing to do with epigenetics. The vast majority of gene switches are switched on by other genes, or by proteins that have been made directly by the genes, in order to switch on other genes. Epigenetics has very little to do with it and there’s no direct evidence that thought influences epigenetics anyway.

Dr Leaf claims that the CREB gene is switched on directly by thought, which then causes the cell to grow healthy branches. But CREB is a gene switch involved in many cells (not just nerve cells), and in many different animal species, including the sea slug, Aplysia [179]. Thus, thought cannot be the switch that triggers CREB expression, unless she’s suggesting that sea slugs have thought. CREB is important to the formation of long-term memory [180]. But again, thought and memory are not the same thing. So it’s incorrect to claim that thought causes the activation of the CREB gene.

**DID JESUS HAVE “TOXIC THOUGHTS AND EMOTIONS”?**

In the Garden of Gethsemane, the gospels record that Jesus, the spotless lamb of God, about to be crucified for the sins of all mankind, was “overwhelmed with sorrow to the point of death” (Mark 14:34, Matthew 26:38), and became so distressed by the ordeal he was about to endure that he literally sweat drops of blood (Luke 22:44). Where do you think Jesus was on the stress spectrum according to those accounts? I’d wager that it wasn’t “healthy stress”.

Rev Bob Deffinbaugh wrote that, “Jesus spent what appears to be at least three agonizing hours in prayer.” He also noted that, “Never before have we seen Jesus so emotionally distraught. He has faced a raging storm on the Sea of Galilee, totally composed and unruffled. He has faced demonic opposition, satanic temptation, and the grilling of Jerusalem’s religious leaders, with total composure. But here in the Garden, the disciples must have been greatly
distressed by what (little) they saw. Here, Jesus cast Himself to the ground, agonizing in prayer.” [181]

There is no other way to explain it - Jesus suffered severe and prolonged mental anguish to the point that it had physical effects. By Dr Leaf’s definition [1: p19], Jesus had “toxic” thoughts.

Dr Leaf also states, “hostility and rage are at the top of the list of toxic emotions” [1: p30], and that “Stress is the direct result of toxic thinking.” [1: p29] But again, scripture documents Jesus displaying emotions and actions that Dr Leaf defines as “toxic”.

In John 2:13-17, it says, “When it was almost time for the Jewish Passover, Jesus went up to Jerusalem. In the temple courts he found people selling cattle, sheep and doves, and others sitting at tables exchanging money. So he made a whip out of cords, and drove all from the temple courts, both sheep and cattle; he scattered the coins of the moneychangers and overturned their tables. To those who sold doves he said, ‘Get these out of here! Stop turning my Father’s house into a market!’ His disciples remembered that it is written: ‘Zeal for your house will consume me.’”

So Jesus saw the sellers and the money exchangers, then in a pre-meditated way, took small cords and fashioned a whip out of them, and proceeded to use that whip to violently and aggressively overturn the tables of the merchants and spill the money of the money changers. John adds a post-script - “Zeal for your house will consume me.” So Jesus wasn’t prancing around for show. He was consumed with a deep, passionate anger.

Indeed, God himself displays anger. There are a number of times in the Old Testament where the wrath of God was kindled, either towards Israel or their enemies. For example, 2 Kings 23:25-27 says, “Notwithstanding the Lord turned not from the fierceness of his great wrath, wherewith his anger was kindled against Judah, because of all the provocations that Manasseh had provoked him withal.” Numbers 11:33 and Deuteronomy 11:16-17 are other examples, and an extensive study on the wrath of God would reveal many more.

In the creation account in Genesis 1 and 2, the scripture describes that God made man in his image. If God has emotions such as anger, and he made us in his image, then we have also been made to experience emotions such as anger.

If God has the capacity for anger and we are made in his image, then he gave us the capacity for anger. If God gave us the capacity for anger, then anger itself isn’t toxic, and neither is it necessarily sinful or impure, since Jesus also displayed anger. Therefore anger, like the other emotions, is neutral. Anger can be used in both maladaptive ways, and in adaptive ways, and likewise, “positive emotions” can be used for maladaptive purposes as well as adaptive purposes. It’s ultimately the use of the emotion rather than the emotion itself that’s the issue. Thus, Dr Leaf’s statement that anger is negative and “toxic” is overly simplistic and ultimately false.

ARE THOUGHTS TOXIC?

In summary, thoughts by themselves don’t have any effect on the brain, because the brain is the driver of thoughts rather than thoughts being the driver of our brains. Studies show that there is no link between “negative” thinking, stress and health behaviours, and psychological therapies such as ACT prove that meaningful improvement can be made in psychological issues by changing behaviour, irrespective of thought. “Negative” thoughts are symptoms of underlying disturbances, not the causes of them.

Dr Leaf makes a number of claims to try and justify her theory of toxic thoughts, but the weight of established scientific evidence of the relationship of the mind and brain, the role of
genes like CREB, and the nature of choice and free will, is against her.

Just as there’s no scientific evidence for toxins in our body, there’s also no scientific support for toxins in our thoughts either.

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**CHAPTER 9 - ALLOSTATIC OVERLOAD: STRESS “BREAKING BAD”**

The TV show “Breaking Bad” told the story of Walter White, a high school chemistry teacher and average family man, who is diagnosed with terminal lung cancer. To support his wife and disabled son after he’s gone, he uses his knowledge of chemistry to launch himself into an underworld career manufacturing crystal meth.

Allostatic overload is stress breaking bad. Stress moves from an agent of growth and change to an agent of disease and death.

Remember from section 2, we discussed that stress is actually more of a positive than a negative. It’s not that stress can’t be bad, because we know from the stress-productivity curve and from Yerkes-Dodson Law that too much stress overwhelms our capacity to cope with it. But the majority of stress is actually beneficial – stress is to our mind what gravity is to our physical body. Without it, we become weak and unproductive. As I outlined in chapter 4, studies in animals show that chronic, manageable stress levels enhanced new nerve cell growth in the brain, and another study showed acute levels of stress actually enhances the immune system, rather than weakens it.

Dr Leaf relies on the General Adaptation Model of stress first proposed by Selye in the 1930’s - a three-stage process of alarm, adaptation, then exhaustion. While it held sway with researchers for most of the 20th century, the weaknesses of the model were exposed more than a decade ago. For example, the General Adaptation Syndrome suggests that the effects of stress are the same no matter what caused it, yet modern research has shown that the different stress systems have different patterns of response depending on what caused the stress. Second, the “fight or flight” response does not apply equally to both sexes; males “fight or flight” whereas females “tend-and-befriend”. Also, “exhaustion”, the third stage of Selye's model, has been superseded by newer knowledge that the stress mediators can have both protective and damaging effects, depending on their pattern of secretion over time [182].

So the basis of Dr Leaf’s understanding and application of the stress concept throughout her books is based on a largely outdated model of stress that cannot be used in a general way. Because of this, and a generous dose of exaggeration, Dr Leaf’s “toxic pathway” theory diverges from the current accepted idea that prolonged or chronic stress is not always harmful, but can be beneficial. Her discussion on stress also has a number of errors relating to the causes of, and the effects of, “toxic” stress.

The purpose of this chapter is to provide a reality check to Dr Leaf’s “toxic pathway” model of stress.

**THE ALLOSTATIC MODEL OF STRESS**

If Dr Leaf’s theory relies on an outdated model of stress, then it’s fair to ask what the currently accepted model of stress is? McEwen and his colleagues proposed a concept that he called allostasis.

All living things maintain a complex dynamic equilibrium - a balancing act of the many different physiological systems that all rely on the other systems working at an optimal range. Imagine trying to stack ten spinning tops on top of each other while trying to keep them
spinning. The body does the chemical equivalent of this very difficult combination of balance and dexterity every day. It’s called homeostasis. This balancing act is constantly challenged by internal or external events, termed stressors. Both the amount of stress and amount of time that the stressor is applied is important. When any stressor exceeds a certain threshold (“too strong, or too long”), the adaptive homeostatic systems of the living thing activate responses that compensate.

The theory of allostasis is related to these homeostatic mechanisms, although not just in terms of stress, but broadly to the concept of any change of the optimal range of these homeostatic balancing processes, in response to a change in the environment or life cycle of an organism [183].

McEwen and Wingfield give an example of some bird species, which change their stress response to facilitate their breeding capacity during mating season. They note that the benefit of the increased chance of breeding is important to the bird, but also comes at a cost of increased susceptibility to some diseases because of the weakening of the stress response at the time [183].

When it comes to stress, we adapt in a similar way. A lack of stress, or an excess of a stressor in some way (either too long or too strong) results in adaptation, which is beneficial, but can come at a cost. This is demonstrated by that broadly applicable U-curve, the stress productivity curve.

Chrousos wrote, “The interaction between homeostasis disturbing stressors and stressor activated adaptive responses of the organism can have three potential outcomes. First, the match may be perfect and the organism returns to its basal homeostasis or eustasis; second, the adaptive response may be inappropriate (for example, inadequate, excessive and/or prolonged) and the organism falls into cacostasis; and, third, the match may be perfect and the organism gains from the experience and a new, improved homeostatic capacity is attained, for which I propose the term ‘hyperstasis’.” [184] And as noted by McEwen, “Every system of the body responds to acute challenge with allostasis leading to adaptation.” [182]

More often than not, we adapt to the stressor, either the same as before, or possibly better. It’s only if the response to the stressor is inadequate, excessive and/or prolonged that stress ends up causing us trouble. This is what people normally think of when they think of stress – called allostatic overload – simply stress breaking bad.

THE NUMBER ONE KILLER!

The problem with using such an outdated model of stress like the General Adaptation Model is that it mislabels nearly every form of stress as harmful. Dr Leaf, and indeed, the popular press, all fall into this trap. It doesn’t matter what the problem is, there’ll be an article somewhere claiming that stress caused or exacerbated it. The way the media describe stress, you’d think it was our number one killer! Blood pressure? Stress. Anxiety? Stress. Cancer? Stress. Flatulence? Stress!

This saturation of the media with negative messages about stress is so pervasive that the negative messages become self-perpetuating. Then when Dr Leaf writes that, “A massive body of research collectively shows that up to 80% of physical, emotional and mental health issues today could be a direct result of our thought lives” [1: p15] or “75 to 98 percent of mental and physical illnesses comes from ones thought life” [2: p37] we assume it must be true, since it sounds so similar to what everyone else says about stress. This is known in scientific circles as Confirmation Bias [185, 186].

DEFINITION AND CAUSALITY
The difference between sensationalism and reality is two-fold: perception and causality.

As we saw in section 2, there are a number of ways to conceptualise stress - mechanical, old-style, modern or toxic. Each concept can highlight either the protective or damaging side of stress. Studies have shown that if we view stress as entirely negative, then any stress is likely to have a maladaptive outcome, whereas viewing stress as potentially positive is associated with an adaptive response to stress [187]. In this sense, our perceptions of stress become like a self-fulfilling prophecy. If all we’re told about stress is that stress is negative, then of course stress will be bad for us.

Defining each disease is also important. Talking about disease in vague, ill-defined terms ensures you’ll be in the ballpark, but the trade-off is that whatever assertion your broad statement contains is diluted by error. Saying, “Heart disease maybe caused by stress”, maybe technically true, but it’s so vague that it becomes devoid of meaning. The media messages about stress are often like this: broad, vague and impotent.

The other issue is causality. Correlation* does not equal causation, which means that just because two things occur together, one does not always cause the other.

In other words, just because symptom B always occurs with disease A doesn’t mean that A causes B. There’s often a common underlying cause, C.

A simple example would be that itchy red eyes and sneezing often go together. Do my itchy red eyes cause my sneezing? No! They have an association, (or correlation* ), but one does not cause the other. The common underlying cause of both my itchy red eyes and my sneezing is the cat that I’ve been patting, and my allergy to cats.

It’s easy to think that something that always happens with another must be cause and effect, but such thinking leads to some pretty crazy assumptions. Williams cleverly demonstrated this with a graph showing that the US road toll is inversely correlated with the importation of lemons from Mexico [188].
When it comes to stress, we know that stress is associated with an eclectic bunch of diseases. But correlation does not equal causation. Just because stress is associated with these diseases doesn’t mean that stress caused these diseases.

Take the relationship between stress and cardiovascular disease. There’s no doubt that stress and heart disease are associated [189, 190], but does stress cause cardiovascular disease? If it does, how does it do it?

If stress were to cause heart attacks, it would either be directly (by directly stopping or reducing the blood flow to the heart to critical levels) or indirectly (by accelerating the other disease processes that lead to the blockage of the coronary arteries, which then causes a heart attack).

I don’t know of any evidence that shows that stress directly blocks the coronary arteries. So if stress were to cause heart attacks, it would be indirectly - accelerating the other risk factors for heart disease, like high cholesterol, high blood pressure, diabetes or chronic inflammation. Let’s look at the relationship between stress and these different risk factors.

High cholesterol

The causes of high cholesterol are diet and genetics. Diets high in fat are likely to give people high blood cholesterol. But it isn't as simple as that. Some people eat huge amounts of fat but have normal cholesterol, and some people live on a diet of lentils and bean broth and still have cholesterol through the roof. This is because of genetics, and the efficiency of their liver to metabolise their cholesterol. Genes account for 40-60% of the risk for high cholesterol [191].

Stress has very little to do with cholesterol directly. A recent paper showed that chronic stress in caregivers of relatives with Alzheimer's affects the expression of one form of a gene
coding for a cholesterol transport protein. This changed the average lipid profile, but only resulted in a small overall risk increase [192].

Some studies show that people who are stressed will tend to eat fatty, salty foods [193] but in terms of cholesterol and heart attack risk, it’s likely that stress will only affect those who are already genetically vulnerable [192].

**Diabetes**

Diabetes Mellitus, the best-known form of diabetes, is a disease of insulin dysfunction. Insulin is a hormone that is secreted from nests of cells in the pancreas. Normally, there is a predictable rise and fall of insulin with a surge of blood sugar. Insulin acts like a key, unlocking a protein 'gate' that lets glucose into a cell.

Type 1 diabetes is an autoimmune disease. The body mounts an immune reaction to its own proteins, attacking the cells in the pancreas that produce insulin. 88% of cases of type 1 diabetes are caused by genetic factors. Environmental factors only contribute the other 12% [95]. These environmental risk factors include possible viral or bacterial infections, and possibly early introduction of cows milk or gluten into the infant diet. Stress is not listed [95].

Type 2 diabetes is considered multifactorial, with a number of influences affecting its course. There is a strong genetic component with 62 to 70% being attributable to genes, and only 30 to 38% being caused by independent environmental factors [194, 195]. Of these other factors, there are some shared genes that increase the risk of type 2 diabetes and obesity together. Sedentary lifestyles and high fat diets predispose to developing type 2 diabetes. But even then, large trials show that overweight pre-diabetic adults can achieve a 58% reduction in their development of type 2 diabetes, but despite intensive dietary and lifestyle modification, 11% go on to develop the disease anyway within four years [96].

Of the others, environmental pollutants may play a minor role. Again, stress is not listed as a major contributing factor [194].

So diabetes is mostly genetic in origin. Stress isn’t documented as a significant environmental risk factor.

**Smoking**

Smoking is linked with nearly every disease that affects human beings. There are more than 7000 different chemicals released in cigarette smoke, including over 60 carcinogens and other poisons. These include Cyanide, Benzene, Formaldehyde, Methanol (wood alcohol), Acetylene (the fuel used in welding torches), and Ammonia [196]. These chemicals in cigarette smoke irritate the lining of the blood vessels, which allows more cholesterol into the walls of the arteries to form plaques. Smoking accelerates the damage from other risk factors like the high blood sugar in diabetes.

The damage done by smoking is partly a dose dependent response [197] although it is a complicated pathway for cardiovascular damage [198].

Initiation of smoking is mediated by genetic risk factors [199]. And nicotine addiction that underlies the habit of smoking is also strongly genetically determined [200-202].

So while most people think it’s purely a conscious choice to take up smoking, there is more scientific data to support the opposite notion, that genetics plays a stronger role than choice does in influencing people to take up smoking, and which people become addicted to nicotine. For example, people with the genetic tendency are more likely to take up smoking and/or more likely to become addicted to smoking. While there is still some choice, it is less
of a choice than the person without the genetic predisposition. It is not a level playing field for the person with the genetic tendencies for smoking.

**High blood pressure**

High blood pressure, known in the medical field as hypertension, and as the name suggests, is defined by having blood pressure that is too high.

The physiological regulation of blood pressure is a complex interaction between the heart and blood vessels, brain, and kidneys [5: p227]. There is also new evidence of the role of the immune system in the onset of high blood pressure and in the way that it causes damage to the vascular system [203].

The interplay of genes and the environment in the development of high blood pressure isn’t as clear as other heart attack risk factors [204], but the immune response to stress is important. However, in the latest research in animal models, the role of high levels of autonomic nerve activity, and the immune system in high blood pressure, are significantly influenced by a gene deficiency [203].

So stress may be a risk factor in the development of high blood pressure, but it seems more likely that, rather than stress being the cause of high blood pressure, it is only an association, through a shared link with specific genes.

The effect of stress on the risk factors for heart disease and other illnesses

So in short, risk factors for heart disease are not significantly influenced by stress, if at all. They are mostly genetically determined [10, 168, 184]. There is a strong association of depression with heart disease, but depression is mainly influenced by genetics as well [149, 168, 205], and stress and depression are two separate entities. Table 5 of the INTERHEART psychological study provides one example, where clear differences were noted in those who were stressed and who were depressed. Interestingly, it also shows a protective effect of having mild to moderate stress compared to the other extremes [190].

No matter which way you cut it, genetics has a significant impact on all of the risk factors for heart disease including depression and stress. Stress itself is influenced by our biology. So even if it were true that stress leads to physical and mental illness, this phenomenon is influenced significantly on a genetic level.

This same pattern is shown in a number of illnesses. Genetics influence 30 to 50% of the risk for nearly every chronic disease. Some diseases have an even higher genetic influence. Prostate cancer, for example, the commonest form of cancer in men (with an incidence higher than the rate of breast cancer in women) [206], has no known risk factors other than genetics [207, 208].

So stress is associated with some illnesses, but not all. But given the influence of genetics over the complex interplay all risk factors, the actual influence of stress is probably minimal, and it’s likely that common genetic or other environmental vulnerabilities may cause both physical illness and stress, making stress just another symptom rather than a cause.

**THE “EFFECTS” OF THE “TOXIC PATHWAY”**

If stress is just another symptom, then how can Dr Leaf list so many conditions in which stress is a “major contributor” [1: p40-3]? Is stress more powerful than I’ve just made out, or is Dr Leaf’s list misinformed?

Lets flesh out Dr Leaf’s list a bit, and compare it to the evidence.

**The Heart**
Dr Leaf starts with the heart and the vascular system. By listing five serious diseases, stress sounds like it’s a killer. But as we’ve discussed, stress is an association with hypertension (high blood pressure), rather than a cause. The others, angina, coronary artery disease, strokes or cerebrovascular insufficiency, and aneurysm (well, at least the abdominal aortic type) are all variations of the same disease process, and all related to hypertension and the other risk factors such as high cholesterol and diabetes. As we’ve just discussed, most of these risk factors are strongly related to genetics, while stress failed to feature as a significant environmental influence for any of them.

Dr Leaf suggests that anger is one of the many toxic emotions that lead to stress [1: p39] and, by implication, causes heart disease. In fact, the opposite may be true. Nakamura et al only demonstrated a small association between anger and heart disease progression, while noting that other authors had found that anger had a protective effect on heart disease, or no difference at all [209]. So rather than being toxic as she suggests [1: p39], anger may be harmless or even protective for your heart.

The Immune System

Dr Leaf proposes that the immune system is “neurologically sensitive to your thought life.” She says that, “When the immune system faces an attack, such as when your thought life is toxic, it generates blood proteins called cytokines, which are known to produce fatigue and depression. In this way, toxic thoughts and the emotions they generate interfere with the body’s natural healing processes. They compound the effects of illness and disease by adding new negative biochemical processes that the body must struggle to overcome.” [1: p41]

Dr Leaf also says that, “A sudden burst of stress lowers immunity (one way to ‘catch a cold’).” [1: p42] Although the experimental evidence shows the opposite, that short term stress actually enhances the body’s immune response [210, 211].

With regard to the role of cytokines, there is evidence that activation or injection of high doses of some cytokines will cause depressive symptoms [212]. However, the same article noted that, “NF-κB and IL-6 responses to psychosocial stress have been shown to be exaggerated in patients with depression, consistent with findings that depressive symptoms are associated with amplified IL-6 responses to antigenic challenge.” [212] In other words, it’s likely that cytokines only cause depression in people who are biologically vulnerable to depression in the first place (that is, genetically predisposed).

It’s also important to understand that the usual trigger of the immune system is not toxic thoughts, or stress, but infection. To fight off an acute infection, the body mounts a behaviourally response called sickness behaviour. Sickness behaviour is an adaptive response [213]. The fever, pains, lethargy, loss of appetite and overwhelming need for sleep may make you feel like garbage, but the enforced rest allows more energy to be diverted to the immune system so that it can fight off the invading infection more effectively.

Sickness behaviour is mediated by the same cytokines that are associated with depression, which is why other than fever, many of these same symptoms of sickness behaviour are shared by depression [213]. So of course giving people high doses of cytokines will make them feel “depressed”. It’s just a different way of describing a normal, functional, adaptive response. True depression is much more complicated, influenced by a number of factors other than cytokines.

The immune system is more complicated on the surface, because while stress does influence the specific functions of the immune system in the lab and in some clinical trials [165], the stress responses seems to enhance some parts of the immune system (such as inflammation and allergic diseases) while suppressing other parts (like the while blood cells).
New thinking on the immune system, backed up by data in animal models, has lead to the Stress Spectrum model [214]. The Stress Spectrum model suggests that the response of the immune system to any stress depends on a number of factors including the duration of stress, the timing of stress relative to the stage of the immune response, and the concentration, duration and nature of the cortisol exposure. It is also influenced by the health of the individual and their genetic and cognitive coping ability [214]. While it requires confirmation with human data, the model sounds remarkably like the model of allostasis as I outlined earlier in the chapter.

The Stress Spectrum model suggests that stress usually enhances the immune response. Ongoing stress may lead to a state where the negative effects of stress are actually the body’s normal feedback mechanism trying to protect itself further. The odds of changing from immune enhancement to immune dysfunction is determined by genes and then cognitive coping styles (which in themselves are strongly genetically determined). But fundamentally, stress is not toxic, it’s protective.

The Digestive Tract

You’ve heard it said that, “The way to a man’s heart is through his stomach”? Food has an effect on our bodies and minds that we as humans have known for aeons.

Dr Leaf believes that the digestive tract bears the brunt of the “toxic pathway” of stress. She says that carbohydrates are comfort foods because they boost serotonin levels, and that any improvements dissipate within 20 minutes. She also says that thoughts can make comfort foods toxic. She claims that “dietitians and nutritionists tell you (or should tell you) never to eat when you’re angry” because “It’s almost as if the anger seeps into the food you eat as your body tries to digest it.” [1: p42-3]

As a family physician on the front line, I hear all sorts of odd health beliefs that people have, and believe me, I’ve heard some pretty bizarre ones. But I have never heard anyone say “never eat when you are angry”, let alone a dietician. Even a Google search only showed up a couple of relevant hits, all of them from pseudoscientific alternative bloggers, without a shred of evidence to back themselves. In actual fact, there is reasonably good evidence that eating may be good around times of extreme emotions, as sucrose (ie: sugar) has been shown to decrease pain experienced by newborn babies undergoing painful procedures [215]. The analgesic effect may be partially related to the fact that a load of pure sugar will increase the levels of tryptophan in the blood stream, which then leads to a rise in serotonin levels [216], which then improves mood. However, Dr Leaf’s statement that carbohydrates are comfort foods because they stimulate serotonin is an overstatement, because a small amount of dietary protein consumed at the same time (as little as 4% of the food) blocks this process [217]. Nearly all foods high in carbohydrates have more than 4% protein, the only exceptions being pure sugar, jelly beans or soft drink/soda. So your serotonin is not going to be enhanced unless you’re binging on jelly beans and Coke. More often than not, comfort eating tends to involve consuming chocolate, which is more influential on the hedonistic rewards pathways requiring dopamine, not serotonin [218].

Dr Leaf then compiles a list of disorders that gives the impression that stress really is toxic to the gut. But like her list of heart problems in the previous section, her list of digestive disorders have very little to do with stress. “Leaky Gut Syndrome” isn’t even a recognised disorder.

Irritable Bowel Syndrome

Of the others on her list, the one that has the strongest relationship to psychosocial stress is
Irritable Bowel Syndrome. But IBS is a very complicated disorder that has only recently begun to be pinned down by medical science.

Irritable bowel syndrome (IBS) is “a chronic condition characterized by abdominal discomfort or pain, altered bowel habits, and often bloating and abdominal distension. The degree of symptoms varies in different patients from tolerable to severe, interfering with daily activity.” [219]

Essentially, IBS patients have a gut that is oversensitive. Something sets it off, and it slows right down (causing constipation) or goes ballistic. The diarrhoea and flatulence from IBS was once described to me as “like an explosion in a sewerage treatment plant.” I’ll leave that one to your imagination!

IBS is now recognised as a disorder of the Neuro-Endocrine System of the gut. This combination of hormone producing cells scattered throughout the gut lining, and the mesh of nerve cells in the wall of the gut, control the intestinal tracts rhythmical muscular contractions, the flow of secretions (“juices”), and the sensory perception of the gut to noxious agents. There are a number of influences that all converge on the NES, including genetics and low-grade inflammation [220], the microbes that live naturally in our gut [221], and dietary factors [219].

The evidence for the relationship of stress to IBS is mixed. Some researchers who study in this field believe that stress is largely responsible for a number of functional bowel disorders, IBS being one of them [222]. However, other authors have reviewed the published literature on stress and IBS, and while it is true that stress can influence the neuro-endocrine system of the gut in patients with irritable bowel syndrome, stress does not cause symptoms in the control groups used in the experimental studies [223].

Now, that may seem like a no-brainer, since by definition, control groups are picked because they don’t have the disease. But what it shows is that the effect of stress on the function of the intestines is only linked to people with IBS. Ninety percent of the population have stress and don’t get irritable bowel symptoms of constipation, diarrhoea or abdominal cramping. At best, stress exacerbates the pre-existing condition, but does not cause IBS.

But there are experts who go one step further, and believe that stress doesn’t even exacerbate the disease. El-Salhy explains, “Many patients with IBS ignore their symptoms and regard them as a normal part of everyday life. IBS patients with anxiety, depression, somatisation or hypochondria are more liable to seek healthcare than other IBS patients. Unless this is borne in mind, incorrect conclusions can be drawn. A hospital-based case-control study showed that patients with IBS have a comparable health-related quality of life, level of psychological distress and occurrence of recent stressful life events to age-matched IBD (inflammatory bowel disease) patients.” [220]

He goes on: “Two percent of patients diagnosed with IBS among the adult residents of Olmsted County, Minnesota, United States, were found to suffer from depression compared to the 16.2% incidence of depression in the entire population of the United States. In conclusion, there is no convincing evidence to show that psychological factors play a role in the onset and/or progression of IBS.” [220]

In trying to marry all of the facts about stress and IBS together, the most logical explanation is that stress does not cause IBS. Stress and IBS may be linked by a common causative factor, such as genetics and possibly early life stress, which predisposes the patient to have both more frequent stress and irritable bowel syndrome. Stress, then, is one small part of a wider disease complex involving inflammation, diet, and changes to the gut bacteria.
The others

The remaining disorders on her list can be tenuously linked to stress, but only because they are symptoms of irritable bowel syndrome. Outside of IBS, constipation is caused by a lack of dietary fibre and water although there are a plethora of other causes, none of which are related to stress [224, 225]. Diarrhoea is usually caused by infections, foods or digestive disorders, not stress [226]. Nausea and vomiting can be caused by anything from irritation of the stomach or duodenum from physical toxins as well as other infections or inflammation throughout the body, severe pain, vertigo, medications, and even pregnancy [5: p803-4]. Cramping is a symptom that co-occurs with other symptoms like diarrhoea and constipation. It’s uncommon to have cramping by itself.

In times gone by, ulcers were always thought to be directly associated with stress and lifestyle factors. That was until Dr Barry Marshall, from the University of Western Australia, underwent an endoscopy to prove he was ulcer-free, and then drank a petri-dish full of Helicobacter pylori. After about a week, he had an endoscopy which showed massive amounts of inflammation of his stomach lining, and was positive for Helicobacter infection [227, 228]. Subsequent work has proven that up to 80% of stomach ulceration (and 90% of duodenal ulcers) are caused by Helicobacter pylori [229]. The use of NSAIDs (non-steroidal anti-inflammatory drugs, such as aspirin and ibuprofen) is the next most important cause [230]. “Stress ulcers” are actually erosions of the stomach lining, caused by a lack of blood flow to the lining of the stomach in patients who are critically ill [231], not because of any toxic thought process.

SUMMARY OF THE “TOXIC PATHWAY”

So when the recent scientific and medical literature is applied to Dr Leaf’s assertions about stress, it becomes clear that rather than being uniformly detrimental, stress is often beneficial. Dr Leaf also confuses correlation and causation. Stress may be associated with various disorders, but it does not cause them. Dr Leaf lists multiple overlapping symptoms as separate disorders, which also confuses the issue. She incorrectly links comfort foods and serotonin, and incorrectly assumes that the “stress” of stress ulcers is psychological stress. She even lists a “disease” that doesn’t exist in the medical literature.

The fundamental problem is Dr Leaf’s use of an outdated model of stress as the basis for her understanding. Therefore, her conceptualization of stress and its effects is inaccurate. She suggests that all long term stress is negative, and that stress can be caused by toxic thoughts when there is no evidence for this, while not considering the evidence for the positive effects of stress on your health.

In short, Dr Leaf teaches that stress is toxic. In reality stress is usually beneficial, rather than breaking bad.
to 80% of physical, emotional and mental health issues today could be a direct result of our thought lives" [1: p15], I wondered whether it could be plausible. 80% is a pretty big number, and as a GP with a fairly broad experience behind me, that number didn’t match what I have seen in my office every day for the last ten years.

Unfortunately, none of her references listed any quotes or information citing thought as causing 80% of all illness. Indeed, her endnote pointed to a collection of a few peer reviewed articles and official websites. The rest were university links without any data at all, a few books, and a documentary talking about epigenetics. Therefore, her statement that “a massive body of research” documented the relationship of thought and disease is an exaggeration.

I wondered if she may have adapted her statement from a quote provided on one of her main source websites, from Dr Paul Rosch, M.D., President of the American Institute of Stress. He said that "75 to 90% of all visits to primary care physicians result from stress-related disorders." [132]

That, too, was another hard number to swallow. The BEACH study, an Australian study constantly tracking general practitioners and their patients, their demographics, diagnoses and subsequent services, suggests a total of about 8% of consultations were related to psychological issues [133]. Unless the US population is radically different to Australia, Dr Rosch’s assertion is still overblown by nearly a factor of ten.

So there really could only be two explanations – I’ve been missing huge swathes of thought related illnesses over the last ten years of my professional life, or reality is a lot different to what Dr Leaf suggests.

Thankfully when Dr Leaf revised her figures in her new book [2: p37-8], she also published her sources, so it’s possible to properly review exactly how she arrived at her conclusion, and compare it to the peer-reviewed, independent medical literature.

That’s what this chapter is all about.

I propose that Dr Leaf’s assertion that “75 to 98 percent of mental and physical illness comes from ones thought life” is incorrect, and indeed, implausible. In the first part of the chapter, I review the validity of Dr Leaf’s statistics and their sources, their strengths and weaknesses, and the validity of how Dr Leaf interprets and applies them. The second part of the chapter outlines evidence from the peer-reviewed literature, which will show that Dr Leaf’s assertion is contrary to modern medical science and common logic.

**DR LEAF’S “SOURCES”**

On page 37 and 38 of her 2013 work, Dr Leaf lists seven bullet points which she cites as evidence that 75 to 98 percent of mental and physical illness come from our thought life [2]. Lets review and analyze them separately.

“A study by the American Medical Association found that stress is a factor in 75% of all illnesses and diseases that people suffer from today.”

First of all, the paper that Dr Leaf refers to, Cohen et al [232], was not by the American Medical Association, but by researchers from Carnegie Mellon University and University of British Columbia. It was published in the Journal of the American Medical Association, an esteemed journal that has been publishing independent medical research for the last century or so. It may seem trivial, but an active research scientist should know the difference between who did the study and who published the study. Errors like this simply undermine Dr Leaf’s credibility.

The article itself provides a good discussion on why stress is associated with some diseases,
cardiovascular disease in particular (which we established in the previous chapter. No one’s denying that fact!)

But nowhere in that article does it say that stress is associated with 75% of illnesses today. Nowhere. I read it three times and used a search engine to make sure I wasn’t missing anything. I’ll say it again - nowhere in the article was the figure of 75% even mentioned once.

Besides, the article provided no conclusive evidence that stress caused any of the four diseases they mentioned, only that there was an association. Remember, correlation does not equal causation. In fact, the authors discussed the significant weakness in ascribing stress to certain diseases, not just once, but several times.

For example, “Although stressors are often associated with illness, the majority of individuals confronted with traumatic events and chronic serious problems remain disease-free.”

Yet Dr Leaf maintains that the majority of illness is related to stress. Her own source directly contradicts her fundamental assertion. Indeed, it appears that she didn’t actually quote the article, just misrepresented it.

“The association between stress and disease is a colossal 85%”

In his book, “Managing Stress: Principles and Strategies for Health and Well-Being”, Dr Seaward said, “Some health experts now speculate that perhaps as much as 70 to 85 percent of all diseases and illnesses are stress-related.” [233]

He also quotes the claim of the American Institute of Stress that “80% of all visits to primary care physicians are for stress-related complaints or disorders.” I’ll discuss this one in more detail soon.

But notice the language he used: “SOME health experts now SPECULATE that PERHAPS AS MUCH as 70 to 85 percent of all diseases and illnesses are stress-related” (emphasis added).

The best Dr Seaward can do is to say that the figure of 70 to 85 percent is the very top of a very broad figure, a figure that’s a wild guess by the minority of health experts. That doesn’t sound particularly credible.

“The International Agency for Research on Cancer and the World Health Organization have concluded that 80% of cancers are due to lifestyles and are not genetic, and they say this is a conservative number”

The International Agency for Research on Cancer and the World Health Organization are leaders in research and health policy formation, and the mention of those organizations in a quote would usually assure validity. And I’m sure the IRC and the WHO probably did conclude that 80% of cancers were due to lifestyles and were not genetic … back in 1979.

Dr Leaf’s source for this citation is “Cancer statistics and views of causes” Science News Vol.115, No 2 (Jan.13 1979), p23. Referencing a journal on genetics from 1979 is the equivalent of attempting to use the “Car-of-the-Year” from 1979 to justify your current choice of vehicle. The technology has advanced significantly, and genetic discoveries are light-years ahead of where they were more than three decades ago. For example, Naidoo et al noted that, “the GWAS approach has dramatically changed the field of human disease genetics, from identifying mostly irreproducible disease associations in the pre-GWAS era to revealing thousands of statistically robust single nucleotide polymorphism (SNP) associations today.” [234]

On the link between stress and cancer, Cohen et al corrects Dr Leaf (again), “Despite these
promising findings, evidence from prospective studies linking stress and cancer incidence in humans is mixed at best.” [232]

I’ll discuss this in more detail soon, but according to the most recent cancer statistics [206], prostate cancer is the most prevalent form of cancer. However, there is no evidence that prostate cancer is influenced by any environmental factors [207, 208].

So it’s clear that Dr Leaf relies on an outdated historical reference to try and justify her current hypothesis, while up-to-date scientific findings are contradictory.

“According to Dr Bruce Lipton, a scientist who has made great strides in understanding the effect of our thinking on our brain, gene disorders like Huntington’s chorea, beta thalassemia and cystic fibrosis, to name a few, affect less than 2% of the population. This means the vast majority of the world’s population come into this world with genes that should enable them to live happy and healthy lives. Lipton says a staggering 98% of diseases are lifestyle choices - in other words, our thinking.”

Dr Bruce Lipton is a paradox. According to his own book, he is a cell biologist who has published a number of peer-reviewed papers in the field, but suffered a stress-related meltdown, and then had a self-described epiphany about the nature of thought and biology. He now teaches in a chiropractic college in New Zealand [235]. So he switched from studying and teaching reputable science to teaching pseudoscience [236-238].

He is a self-confessed mystic who believes that God is the Earth’s biosphere. I quote, “A number of you critical readers may rightly be skeptical of my claim that Earth is Heaven. For by definition, Heaven is also the abode of the Deity and the blessed dead … This Earth is Heaven? The Deity lives here? He knows the Deity? The answers to those questions are: yes, yes, and I believe I do. Well, to be completely honest, I don't know all of you. For God's sake there are over six billion of YOU. And to be fully honest, I don’t really know all of the members of the plant and animal kingdom either, though I believe that they also comprise God. In the immortal words of Tool time's Tim Taylor: 'Baaaack the truck up! Is he saying that humans are God?’ Well … yes, I am.” [235: page xxvi]

He published his last scientific paper in 1992 and started publishing non-mainstream work in 1998. I did a search for his articles using Google Scholar and Pubmed, and since 1998, the only papers I could find that cite him are non-mainstream.

Let me clarify: Just because someone’s not recognised by the mainstream scientific community does not automatically disqualify their opinions. But it does conflict with Dr Leaf’s description of him as “a scientist who has made great strides in understanding the effect of our thinking on our brain.” That’s Dr Leaf’s interpretation, not one shared by the scientific community.

Even allowing for Dr Lipton’s alternative worldview and propensity for pseudoscience, a much greater problem for this citation is Dr Leaf’s hyperbolic paraphrasing.

What Dr Lipton said in his book was,

"Of course, there is no doubt that some diseases, like Huntington's chorea, beta thalassaemia, and cystic fibrosis, can be blamed entirely on one faulty gene. But single gene disorders affect less than two percent of the population; the vast majority of people come into this world with genes that should enable them to live a happy and healthy life. The diseases that are today's scourges - diabetes, heart disease, and cancer - short circuit a happy and healthy life. These diseases, however, are not the result of a single gene, but of complex interactions among multiple genes and environmental factors." [235]
I agree with Lipton’s fundamental premise - most human traits are born of a complex interaction between multiple genes and the environment – though he goes beyond the best evidence of science by claiming the environment is the dominant force over genetic factors. Later in his work, he goes well beyond the boundaries of scientific credibility by suggest there’s a metaphysical link between cell function and our beliefs. Dr Leaf then exaggerates Lipton’s distortion by reinterpreting his words to suit her assumptions.

Dr Lipton’s statement:
“These diseases, however, are not the result of a single gene, but of complex interactions among multiple genes and environmental factors.”

has been morphed by Dr Leaf into:
“Lipton says a staggering 98% of diseases are lifestyle choices - in other words, our thinking.”

Note the difference - Lipton didn’t say anything about thinking or lifestyle choices. That’s Dr Leaf’s interpretation. Dr Lipton made it clear that the interplay is within “the environment”, not thought. Dr Leaf misinterprets, misquotes, and misleads.

“According to W.C Willett (balancing lifestyle and genomics research for disease prevention Science (296) p 695-698, 2002) only 5% of cancer and cardiovascular patients can attribute their disease to hereditary factors.”

Unlike most of Dr Leaf’s sources, Professor Willett is the real deal. He is a Professor of Epidemiology at the Harvard School of Public Health. He is a lead author of large, long-term cohort studies such as the Nurses Health Study. His opinion is worthy of attention, which is why it’s such a shame when Dr Leaf erroneously quotes his research.

For example, in the paper that Dr Leaf cited, Prof Willett said, “Highly penetrant mutations, which account for conspicuous clustering of diseases within families, are rare and appear to account for less than 5% of major cancers and coronary heart disease.” [239]

The first thing to point out is that this paper dates back to 2002. Even though it was only published twelve years ago, genetic research has improved exponentially since then, the growth accelerating since 2005 [234]. The information may have been right in its time, but it’s now outdated.

Secondly, Dr Leaf paraphrases by saying that hereditary factors account for only 5% of cancer and cardiovascular disease. But Prof Willett didn’t say that at all. He said that less than 5% of major cancers and coronary heart disease were due to highly penetrant mutations. Low penetrance polymorphisms of multiple genes account for a significant percentage of risk for cancers and cardiovascular risk (see below). Broadening the quote by changing the wording is blatantly misleading.

I will cover this in more detail soon, but looking at the latest gene x environment studies for cancer and cardiovascular diseases shows genetics has a rough average influence of 50%. Claiming that only 5% of cancer and cardiovascular disease is caused by hereditary factors is nonsense.

“According to the American Institute of health, it has been estimated that 75 – 90% of all visits to primary care physicians are for stress related problems (http://www.stress.org/americas.htm). Some of the latest stress statistics causing illness as a result of toxic thinking can be found at: http://www.naturalwellnesscare.com/stress-statistics.html”

As a researcher, Dr Leaf should be aware of the levels of evidence [240]. The levels of evidence is essentially a grading scheme for classifying scientific research and opinion from
the strongest, most rigorous (Level I-1, Meta-analysis of multiple quality randomised controlled trials, like a Cochrane Review) through seven different levels to the weakest form of evidence (Level IV, Anecdotal, which are essentially stories and opinion, “… someone once told me …”)

Websites that are politically, ideologically or financially motivated are, on the ladder of credibility, down on the bottom rung. They are not peer reviewed to systematically remove biased material. University or official government health sites like the CDC in America or the NHMRC in Australia offer stronger evidence, and are often worth noting. Some other health websites like the Better Health Channel (http://www.betterhealth.vic.gov.au) are valid sources of information, provided that they cite their sources so they can be scrutinized.

But unfortunately, sites like stress.org and naturalwellnesscare.com are examples of strong subject bias. Citing them as sources of opinion is fair, but citing them as sources of fact is not. These websites are not independently peer-reviewed, and both suffer from a blatant pro-stress bias.

Offering them as factual evidence demonstrates either sloppy science or intellectual dishonesty.

“Dr H.F. Nijhout (Metaphors and the Role of Genes and Development, 1990) genes control biology and not the other way around.”

Dr Leaf contradicts herself again. After spending most of the first part of chapter 1 of “Switch On Your Brain” stating that we weren’t victims of our genes or our biology, this quote sounds like she is saying the opposite. Is Dr Leaf saying that genes DO control development, and by logical extension, we are controlled by our biology? Or has she misquoted again?

In actual fact, Dr Leaf is playing Chinese Whispers* by trying to quote from a secondary source. Bruce Lipton quoted Dr Nijhout in “Biology of Belief.” [235: p21-2] Looking back at Lipton’s version, it appears that Dr Leaf has “quoted” Dr Nijhout but actually ended up taking a phrase from Dr Lipton’s paragraph on Dr Nijhout.

The value of Dr Nijhout’s quote to Dr Leaf’s theory is questionable. Lipton quoted Nijhout because Nijhout was suggesting that most scientists have too high a regard for a particular model of gene switching and activity. But whether scientists have a mildly unrealistic view of the power of genes does not, in anyway, prove that 75 to 98% of all diseases are related to our thoughts. Nijhout says nothing about thoughts or disease. His discussion was about a model of gene activity and switching, and not the effects of thought on the genes themselves.

So overall, Dr Leaf’s cited evidence is so weak as to be useless. Of the seven sources that she cites, one is thirty years out of date, one is ten years out of date and misquoted, one links to websites which are clearly biased, one is a misquote of a misquote that isn’t even relevant, one directly contradicts her twice, another provides a value that is exaggerated and vague, and the other is a hyperbolic exaggeration of an already distorted view of science written by an agnostic cell biologist who has embraced pseudoscience.

Dr Leaf’s statement that “75 to 98 percent of mental and physical illness comes from ones thought life” is baseless.

**EVIDENCE CONTRADICTING DR LEAF**

So the scientific basis for Dr Leaf’s statement is paper-thin. What does modern peer-reviewed scientific literature say about the influence of thought on our health?

When considered in the global and historical context [241], the vast majority of illness is
related to preventable diseases that are so rare in the modern western world because of generations of high quality public health and medical care.

In a recent peer-reviewed publication, Mara et al state, “At any given time close to half of the urban populations of Africa, Asia, and Latin America have a disease associated with poor sanitation, hygiene, and water.” [242] Bartram and Cairncross write that “While rarely discussed alongside the ‘big three’ attention-seekers of the international public health community—HIV/AIDS, tuberculosis, and malaria—one disease alone kills more young children each year than all three combined. It is diarrhoea, and the key to its control is hygiene, sanitation, and water.” [243] Hunter et al state that, “diarrhoeal disease is the second most common contributor to the disease burden in developing countries (as measured by disability-adjusted life years (DALYs)), and poor-quality drinking water is an important risk factor for diarrhoea.” [244]

Diarrhoeal disease in the developing world - the second most common contributor to disease in these countries, afflicting half of their population - has nothing to do with thought. It’s related to the provision of toilets and clean running water.

We live in a society that prevents half of our illnesses because of internal plumbing. Thoughts seem to significantly contribute to disease because we are protected from common diseases affecting the rest of the world - illnesses prevented by our clean water and sewerage systems. Remove those protective factors and thought no longer appears so significant.

In the same manner, modern medicine has become so good at preventing diseases that thought may seem to be a major contributor, when in actual fact, most of the work in keeping us all alive has nothing to do with our own thought processes. Like sanitation and clean water, the population wide practices of vaccination and health screening such as pap smears, have significantly reduced the impact of preventable disease.

In the global context, “Recent estimates of the global incidence of disease suggest that communicable diseases account for approximately 19% of global deaths” and that “2.5 million deaths of children annually (are) from vaccine-preventable diseases.” [245] Again, that’s a lot of deaths that are not related to thought life.

Since 1932, vaccinations in Australia have reduced the death rate from vaccine-preventable diseases by 99% [246]. Epidemiological evidence shows that when vaccine rates increase, sickness from communicable disease decreases [247: Fig 2, p52 & Fig 8, p67].

Population based screening has also lead to a reduction in disease and death, especially in the case of population screening by pap smears for cervical cancer. Canadian public health has some of the best historical figures on pap smear screening and cervical cancer. In Canada, as the population rate of pap smear screening increased, the death rate of women from cervical cancer decreased. Overall, pap smear screening decreased the death rate from cervical cancer by 83%, from a peak of 13.5/100,000 in 1952 to only 2.2/100,000 in 2006, despite an increase in the population and at-risk behaviours for HPV infection (the major risk factor for cervical cancer) [248].

Around the world, the other major cause of preventable death is death in childbirth. The risk of a woman dying in childbirth is a staggering one in six for countries like Afghanistan [249] which is the same as your odds playing Russian Roulette. That’s compared to a maternal death rate of one in 30,000 in countries like Sweden. The marked disparity is not related to the thought life of Afghani women in labour. Countries that have a low maternal death rate all have professional midwifery care at birth. Further improvements occur because of better access to hospital care, use of antibiotics, better surgical techniques, and universal access to the health system [249]. Again, unless one’s thought life directly changes the odds of a
midwife appearing to help you deliver your baby, toxic thoughts are irrelevant as a cause of illness and death.

Unfortunately for Dr Leaf, her statement that “75 to 98 percent of mental, physical and behavioural illnesses come from ones thought life” is a myth, a gross misrepresentation of the association of stress and illness.

In the global and historical context of human health, the majority of illness is caused by infectious disease, driven by a lack of infrastructure, public health programs and nursing and medical care. To us in the wealthy, resource-rich western world, it may seem that our thought life has a significant effect on our health. That’s only because we have midwives, hospitals, public health programs and internal plumbing, which stop the majority of death and disease before they have a chance to start.

Unless midwives and toilets are the direct result of our thinking, Dr Leaf’s statement is invalid in the global context of health and disease.

WHAT DR LEAF SHOULD HAVE SAID

Dr Leaf’s assertion is baseless, and is contradicted by global health data. What then would be a more accurate statement? How could she correct her assertion to bring it in line with the best medical evidence available?

A better statement would be, “Up to seventy-five percent of mental and physical illness comes from poverty and genetics.”

We have already seen from the global data from the WHO [241] and from authors such as Mara et al, Bartram and Cairncross and Hunter et al that the lack of sanitation and clean drinking water is a significant contributor to global illness [242-244], as is the lack of widespread vaccination programs across the developing nations [245], the lack of public health programs like cervical screening, and the poor access to midwifery care and hospitals [249]. I’m not going to labour the point any further, but suffice to say, the bulk of the global burden of disease is related to poverty throughout the developing world.

When poverty-related diseases are taken out of the picture, as is the situation in the first world, the main contributing factor becomes genetics.

Since 2005, new techniques for gene sequencing have revealed multiple genes, each with an individually minor effect, but when combined, significantly contribute to the risk of developing particular diseases. Gene x Environment studies use a variety of techniques to deduce the separate contribution that genes and environmental factors have on the risk of developing a disease, or on the risk factors for a disease.

For example, here is a summary of the risk factors for cardiovascular disease and their genetic susceptibility.

HIGH CHOLESTEROL - Genetic susceptibility accounts for 40-60% of the risk for high cholesterol [191].
DIABETES - Genetic factors account for 88% of the risk for type 1 diabetes [95]. There is a strong genetic component of the risk of type 2 diabetes with 62-70% being attributable to genetics [194, 195].
SMOKING - nicotine addiction has a strong hereditary link (50-75% genetic susceptibility) [202].
HYPERTENSION - While part of a much greater mix of variables, genetics are still thought to contribute between 30% and 50% to the risk of developing high blood pressure [204].

It’s clear that environmental variables play a significant part in the risk of developing these
traits. However, it’s also clear that the current evidence points to a much greater genetic contribution, usually greater than 50% of each factor listed.

Similarly for cancer, the effect of genes on the risk of developing most cancers is usually around 50%. I’ve summarised the recognised Gene x Environment interactions of the four most prevalent types of cancer (as per the review “Cancer Statistics 2013” [206]).

PROSTATE - There are only two risk factors for prostate cancer, familial aggregation and ethnic origin. No dietary or environmental cause has yet been identified [207]. It is most likely caused by multiple genes at various locations in the genome [208].

BREAST - Genes make up 25% of the risk factors for breast cancer, and significantly interacted with parity (parity is the number of children born to a woman) [250].

LUNG/BRONCHUS - Lung cancer is almost exclusively linked to smoking, but nicotine addiction, has a strong hereditary link (50-75% genetic susceptibility) [202] with modest genetic effects noted for smoking initiation and smoking cessation [201].

COLORECTUM - Approximately one third of colorectal cancer is genetically linked [251].

SUMMARY

So in summary, Dr Leaf first asserted that “A massive body of research collectively shows that up to 80% of physical, emotional and mental health issues today could be a direct result of our thought lives” but failed to cite any credible scientific evidence to support her claim.

She revised her figures and her quote, asserting that, “75 to 98 percent of mental and physical illness comes from one’s thought life.” But on closer inspection of both her cited evidence and the scientific data on illness in the global context, her statement is proven to be a gross misrepresentation of the association of stress and illness.

In reality, the majority of mental and physical illness across the spectrum of human existence is related to poverty and genetics, neither of which is related to ones thought life.

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CHAPTER 11 - HEART SCIENCE

The human heart: the metaphorical source of our feelings and expressions, an emotional enigma that is both a generator of love and its barometer.

It’s said that you can have a heart of gold, a heart of stone, a heart of devotion or a heart of compassion. You can be kind hearted, broken hearted, or heartless. Your heartstrings can be tugged, and you can wear your heart on your sleeve. Your heart can be in the right place, or you can be young at heart. You can win someone’s heart, lose heart, or set your heart on something or someone. Your heart can skip a beat or it can figuratively stop beating.

The heart is so revered by humanity that references to it pepper all aspects of our culture, from historical literature to popular music and everyday conversation. Such cultural reverence isn’t given to other important parts of the body such as lungs or kidneys. When was the last time someone said, “I love you with all my spleen.” Or, “That guy has a pancreas of gold!”

The history of medicine explains some of the reasons why the heart has become synonymous with love and emotion. Ancient Babylonians thought that the liver was the center of feelings and emotions; the heart was the center of the mind; the stomach was the center of strength and courage. The ancient Egyptians, on the other hand, thought that the heart was the center of feelings and emotions, a position that Greek and Arab physicians then adapted, and Roman physicians like Aristotle and Galen took as fact [252]. But it was a man named Herophilus, a
Greek physician working in Alexandria, Egypt, around 300BC, who set things straight. With rigorous anatomical studies on the nervous system, he proved that the brain and not the heart was the seat of intelligence. But the idea of the heart as our emotional centre never left the philosophical and literary worlds, and thus, the concept still lives on today.

The Egyptian belief that individual organs were responsible for emotions and diseases also lead to other theories, the echoes of which still linger in our modern medical and literary works: “The first mental disorder attributable to women, and for which we find an accurate description since the second millennium BC, is undoubtedly hysteria. The first description referring to the ancient Egyptians dates to 1900 BC (Kahun Papyrus) and identifies the cause of hysterical disorders in spontaneous uterus movement within the female body.” [253]

In other words, the ancient Egyptians believed that only women suffered hysteria, because they thought the uterus would move around the woman’s body, disrupting the action of other organs and causing symptoms.

As noted by Tasca et al, “We also find indications of the therapeutic measures to be taken depending on the position of the uterus, which must be forced to return to its natural position. If the uterus had moved upwards, this could be done by placing malodorous and acrid substances near the woman’s mouth and nostrils, while scented ones were placed near her vagina; on the contrary, if the uterus had lowered, the document recommends placing the acrid substances near her vagina and the perfumed ones near her mouth and nostrils.” [253]

Somehow I can’t imagine a woman already stricken by panic would be helped, in any way, by a bunch of men pushing rotten meat under her nose and flowers at her genitals.

Thankfully, medicine has progressed since then, and the idea that Herophilus proposed three hundred years before the birth of Jesus - that the brain is the centre of all thought and emotion - has become the mainstay of medical thinking.

However, Dr Leaf would have us believe that there is still some truth in an ancient notion more than two thousand years old. She writes that, “Toxic stress is particularly powerful because your heart is not just a pump. It is actually like another brain.” [1: p40]

She continues: “It is proving to be a real intelligent force behind the intuitive thoughts and feelings you experience.” [1: p40]

And: “The signals your heart sends to your brain influence not just perception and emotional processing, but higher cognitive functions as well.” [1: p41]

So how does the “mini-brain” function? She explains in chapter 6, “Your heart is in constant communication with your brain and the rest of your body, checking the accuracy and integrity of your thought life. As you are about to make a decision, your heart pops in a quiet word of advice, well worth listening to, because when you listen to your heart, it secretes the ANF hormone that gives you a feeling of peace.” [1: p62]

She repeats the same information nearly word-for-word in her new book [2: p177]. So these ideas are something that she still believes in.

To summarise, Dr Leaf believes that the heart provides inner peace and influences higher cognitive functions through the nerves between the brain and the heart, and the chemical called ANF. Despite Dr Leaf’s claims that this concept is a scientific breakthrough, mainstream science does not agree with her.

First, lets look at the arguments that Dr Leaf proposes to support her position, and then I’ll outline the evidence from modern clinical science that both contradicts Dr Leaf’s theory, and demonstrates the real physiology of the heart and the brain together.
“EVIDENCE” FOR THE HEART AS A MINI-BRAIN

In her 2009 work, Dr Leaf bases her assertions of the “Heart-Mini-Brain” hypothesis on the information contained in one website, HeartMath = http://www.heartmath.org/research/science-of-the-heart/introduction.html. She also cites a book, The HeartMath Solution, authored by the founders of the website. Dr Leaf does not offer any other support for her position other than that of HeartMath. Indeed, when she states the same information in her new book as well, she still only quotes HeartMath.

So then, does HeartMath offer convincing evidence that the heart is really a mini-brain? There seems to be a lot of science to go through on their site, but on further analysis, there are only a few genuine citations. Many of their references are unpublished work or abstracts presented at conferences. As evidence goes, it’s not very strong.

Other citations, such as “The Electricity of Touch: Detection and measurement of cardiac energy exchange between people” [254] aren’t scientific papers at all. Even the authors admit it: “The research described here was not designed as a comprehensive, rigorous study to yield results to be subject to statistical analysis, and is not intended to be presented or evaluated as such a study … The results described in this paper are representative examples of the types of data that have been collected from numerous experiments conducted with many different subjects over several years’ time.”

There is nothing wrong with expressing your view or sharing your theory. But despite the study’s disclaimer, HeartMath cites this paper as evidence for an energy connection between people: “This study represents one of the first successful attempts to directly measure an energy exchange between people, and provides a solid, testable theory to explain the observed effects of many healing modalities that are based upon the assumption that an energy exchange takes place.” [255]

So HeartMath are happy to use guesswork and opinion as the foundation for their theories, which in itself doesn’t prove them invalid, it just ruins their scientific credibility.

But to be thorough, lets still examine what Dr Leaf via HeartMath says about the heart as a little brain. HeartMath believe that the heart has a “little brain” because:

> The heart has a network of 40,000 neurons within it, called sensory neurites, which detect circulating hormones, neurochemicals, and sense heart rate and blood pressure.

> The heart secretes “neurotransmitters” and other hormones, which have an effect on the brain, such as atrial natriuretic factor, and oxytocin.

> The heart communicates with the brain and the rest of the body through neurological, biophysical, biochemical and “energetic” (ie: electromagnetic) means [132, 255].

HeartMath states that, “The heart’s brain is an intricate network of several types of neurons, neurotransmitters, proteins and support cells like those found in the brain proper. Its elaborate circuitry enables it to act independently of the cranial brain – to learn, remember, and even feel and sense.” [132]

And, “More recently still, it was discovered that the heart also secretes oxytocin, commonly referred to as the ‘love’ or ‘bonding hormone.’ Beyond its well-known functions in childbirth and lactation, recent evidence indicates that this hormone is also involved in cognition, tolerance, adaptation, complex sexual and maternal behaviors as well as in the learning of social cues and the establishment of enduring pair bonds. Remarkably, concentrations of oxytocin in the heart are as high as those found in the brain.” [132]

So the “evidence” looks plausible on the surface, but when it’s considered in a broader
biological context, the weaknesses of the theory start to appear. For example, my heart may have 40,000 neurons, many of which are sensitive to circulating hormones, neurochemicals and which sense and feel, but then again, so does my rectum. Does my rectum have a mini-brain as well?

Indeed, the entire gastrointestinal tract has more nerve cells within it than the entire central nervous system, and we are much more aware of sensations from our gut on a daily basis than we are of our heart. The GIT also contains almost all of the “neurotransmitters” that are also found in the brain [220]. If anything, that would make the gastrointestinal tract a much better candidate for having a mini-brain, and some have even suggested it [256]. But most of our organs or our limbs have large, organized and highly functional neural networks, yet they don’t think, plan, or control other parts of our body. Does the skin have a mini-brain too, or the uterus, or the spleen? The answer is no. Our brain does not delegate its work to other organs. Doctors and scientists sometimes say that, “the gut has a mind of its own”, but they’re talking metaphorically, not literally. Is the way to a man’s heart literally through his stomach? Of course not. And neither the gut, nor the heart, has a mini-brain.

HeartMath also state that the heart produces oxytocin, which then has an effect on the brain. Actually, the heart has a large number of oxytocin receptors, proteins that receive the hormone signal. Some oxytocin is produced by the heart itself [257] although the vast majority of the production of oxytocin is from the brain [258]. The heart is very sensitive to oxytocin signals because oxytocin causes the release of atrial natriuretic peptide (ANF) from the heart, which then acts to modulate blood pressure [257]. The oxytocin from the heart isn’t required for cognitive or emotional processing in the brain.

Then there is the claim that the electromagnetic signal generated by the heart influences the energy of every cell in the body. The electrical signal from the heart can be picked up by specialised electrodes placed on the skin from as far away as the lower leg. This measurement is performed thousands of times every day in doctors offices and hospitals worldwide. It’s called the ECG (or the EKG in America).

ECG stands for electrocardiogram. To perform an ECG, the patient lies on a bed, and highly sensitive electrodes are placed at standardised points on the limbs and on the chest. The patient should lay still and breathe gently, and a ten second sample of the heart’s electrical current is recorded at all twelve “leads” simultaneously.

Each “lead” of the standard 12-lead ECG is actually a measurement of flow of electrical current between two of the electrodes placed on the skin. Electrical current moving towards the positive terminal of the lead makes the line go up, and electrical current moving away from the positive terminal makes the line go down. Each bump and wave of the ECG line represents the flow of electrical current within different parts of the heart within the cardiac cycle.

Most important for our discussion here, the height of the ECG wave, called the amplitude, is only about 1 to 2 millivolts [5: p137]. To give you an idea of how small that amount is, the standard AA sized alkaline battery is capable of producing 1.5 volts. So in comparison, the ECG signal detectable at the skin is 1500 times smaller than a standard battery. The signal from the heart is so delicate that it can only be detected by a machine with electrodes coated with high conductance gel, and a specialized electrical filter to reduce the background electrical noise produced by the muscles.

Compared to all of the electrical noise generated by the body, the signal of the heart is small and soft, and is easily overwhelmed. It’s like a single choirboy trying to sing Amazing Grace in the middle of a mosh-pit at a heavy metal concert. Suggesting that the hearts electrical
signal is able to influence the other cells and tissues in this chaos of electrical current are far-fetched.

Likewise, the magnetic signal of the heart is also extremely weak. An MCG, the magnetic equivalent of the ECG, is measured in units of picoTeslas [259], or one trillionth of a Tesla. To give some comparison, the Earth’s background geomagnetic field is around 50,000nT in the UK [260], while your average fridge magnet is 10 milliTesla [261], about one billion times stronger than the signal detectable from the heart. To get a useful reading, the patient has to be locked in a tiny room that is magnetically shielded to avoid the noise of everyday electromagnetic signals. Unshielded machines are available but require high-order gradiometers, synthetic gradiometers, integrated reduction devices and advanced post-processing to partially compensate for the background magnetic noise [259]. Again, muscles and other bioelectrical signals also generate magnetic fields, so the suggestion that a weak signal, easily swamped by the magnetic signals of the body and the environment, could somehow influence the rest of the body’s cells is hard to believe.

THE “STILL SMALL VOICE” COMES FROM THE BRAIN

So if the still small voice that Dr Leaf is referring to doesn’t come from the heart, then where does it come from?

Dr Leaf states, “Your heart is in constant communication with your brain and the rest of your body, checking the accuracy and integrity of your thought life. As you are about to make a decision, your heart pops in a quiet word of advice ...” [1: p62] Is she referring to the moral conscience, evaluative judgement, or operational prudence (ie: making smart decisions)? Either way, the foundations for all three possibilities are found in the frontal parts of the brain.

Mendez summarised the scientific evidence on the moral conscience, “This neurobiological evidence points to an automatic, emotionally-mediated moral network that is centered in the ventromedial prefrontal cortex (VMPFC), particularly in the right hemisphere.” [262]

Evaluative judgements (for example: “I like One Direction = Yes/No”) are the assessment of an external or internal stimulus on an internal scale related to the person’s value system (preferences, norms, aesthetic values, etc). These are largely processed within the anterior frontomedian cortex [263].

In terms of making appropriate decisions, the rewards value for a choice is processed in the left ventro-medial prefrontal cortex, and the striatum [264]. Feeling positive about a decision is the result of the dopamine neurotransmitter, which is one of the main neurotransmitters used in the connections between the nucleus accumbens, striatum and the pre-frontal cortex. When dopamine pre-cursors have been depleted in the body, the rewarding component of decision-making is lost [265].

So the scientific consensus is that the pre-frontal cortex and dopamine are responsible for the still small voice that helps us with decisions, rather than the heart.

ANF

Dr Leaf, via HeartMath, stated that it was Atrial Natriuretic Factor, or ANF for short, that was responsible for the feeling of peace after “listening to your heart”, rather than dopamine.

ANF originally got its name from its origin (it’s produced by the walls of the atria, the top two chambers of the heart) and for its action (natriuretic means that it acts to excrete sodium). ANF is released from the cardiac muscle cells in response to excessive stretch of the wall of the atria, usually in response to an increase in the volume of blood in the body [5: p376]
(although adrenaline can also trigger its release [266]). It’s not particularly significant compared to other mechanisms for controlling blood volume, because a large infusion of ANP only causes a small change in blood volume, which lasts for about 24 hours before being compensated for by other physiological mechanisms [5: p376].

Over the decades since it was first described, further study showed that there were four different forms of ANF: short protein chains called peptides, found in different parts of the body, such as the heart, brain, kidneys and blood vessels. Together they work to dilate the blood vessels to decrease blood pressure, enhance the salt and water excretion by the kidneys, and reduce thirst and the desire for salt, which decreases the overall blood volume [266]. It also blocks the background activity of the sympathetic nervous system (the fight-or-flight system) on the blood vessels which allows them to dilate, assisting in the reduction of blood pressure [267]. The combination of effects helps the body control the volume of blood the heart is required to push around, ensuring it’s not overloaded.

But it’s the effect that ANP has on the sympathetic nervous system that has excited some scientists about the possible effect of ANP on anxiety. In small human trials, panic attacks were induced using a digestive hormone called CCK4, but pre-treatment with ANP reduced this effect, although it was less effective in subjects with a known diagnosis of panic disorder [268]. A similar study was performed, again in the lab, with a very small number of patients, but this time the ANP was induced by 30 minutes of aerobic exercise. This study showed a similar result, that exercise-induced increases in ANP also reduced CCK4-induced panic attacks [269].

This sounds like a win for ANP, and certainly, there is a plausible mechanism through which ANP may reduce panic symptoms, through the reduction of the sympathetic tone. But while it’s fine in theory, there are a number of difficulties in the real life application of the findings. Firstly, the numbers used in the trials were very small, with only two published studies on the subject that I could find, one with 18 subjects [268], and the other with only 10 [269]. The statistical power of such small cohorts means that they’re very hard to extrapolate.

Secondly, the dose of the CCK used to induce the panic attacks and the dose of the ANP used to truncate them, were extremely high compared to normal levels. For example, the dose of CCK in the study by Wiedemann [268] was 19,000 times greater than the normal physiological levels of CCK and still about 3,000 times greater at the peak concentration of CCK after a fatty meal. Similarly, the dose of ANP used was about 1000 times greater than normal physiological levels.

Just as we don’t suffer from panic attacks every time we have a meal, it’s highly unlikely that ANP is ever at a physiological level high enough to offer meaningful anxiety reduction in a real life setting. For example, heart failure causes huge amounts of ANP to be released [5: p261]. Despite disagreement by some authors [270] the vast majority of patients with CCF have high anxiety [271], despite their huge amounts of circulating ANP.

So while ANP has very interesting effects on anxiety in a laboratory setting, it’s not associated with feelings of peace in real life. Its function is to help regulate blood volume. It is not a cognitive checkpoint.

**THE HEART-AS-A-MINI-BRAIN CONCEPT – EVERYTHING OLD IS NEW AGAIN**

In conclusion, there is no tangible scientific evidence that the heart acts as anything other than a heart. The heart is not a mini-brain any more than your spleen, liver or uterus is a mini-brain. In fact, if Dr Leaf’s criteria for a mini-brain were strictly followed, the intestines make for a much better candidate for a mini-brain than the heart ever would.
But the main point here is that the notion that the heart (or any other organ) is in any way responsible for cognitive functioning was disproven two millennia ago. To seriously advocate that the heart acts to guide thinking is no different than suggesting a hysterical woman has a migrating uterus. It’s harking back to the dark ages, and is completely at odds with modern scientific knowledge.

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CHAPTER 12 - EPIGENETICS

Are identical twins really identical?

Most people would say, “Well, they have the same DNA don’t they? Of course they’re identical.”

It’s true that identical twins have the same DNA. As embryos, they start off as one cell, but at the time of the first cell division from one cell into two, the eggs fully separate. They start to divide again as two individual cells, forming two individual embryos from a single fertilized egg.

But on the long road from a single cell to the trillions that make up a human being, subtle changes emerge that give rise to differences in the physical characteristics (the “phenotype”) of each twin.

Scientists wanted to know why. They had the same genes, so why didn’t all the genes turn on in the same sequence and give rise to twins that should be almost carbon copies of each other? Were there switches that helped to turn the genes on or off, that differed between each twin? Eventually, the study of these genetic switches (in twins, plants, insects and human disease) would form the science of epigenetics.

Epigenetics is often misunderstood. The multiple definitions that have been used by different researchers over the last few decades hasn’t helped the confusion [272-275]. But to think of it more simply, epigenetics is the study of mechanisms that change the action of DNA, without change to the DNA code itself, some of which may be passed onto the next generation of cells.

The epigenetics involved in the function and replication of adult cells has been fairly well studied. But when it comes to the epigenetics that is involved in the passing of characteristics from generation to generation, there isn’t much data from animal studies, and even less from human studies. Because this side of epigenetics is poorly understood, a lot of myth gets easily passed off as fact in the lay scientific media. When it comes to the passing of epigenetic ‘marks’ from generation to generation, the vacuum of knowledge is filled with speculation that seems to fit our preconceived ideas.

Bird sums it up: “Despite the paucity of data from animal studies, this type of epigenetics has caught the general imagination because, in principle, it is stable but potentially affected by the environment. The possibility that acquired ‘marks’ can be passed from parents to children has a deliciously Lamarckian flavour that has proved difficult to resist as a potential antidote to genetic determinism.” [277]
This theme, that we are not the sum of our genes but that we can make our own choices and rewire our thoughts, is one of Dr Leaf’s key themes. She often claims that epigenetics is science “finally catching up with the Bible”. She also teaches that toxic thoughts create epigenetic marks which are then passed on to your children, as if epigenetics was the biological vehicle for the “Sins of the Fathers” affecting their children, grandchildren, “unto the third and to the fourth generation.” (Exodus 34:7) So it’s important to establish what the current scientific understanding of epigenetics is, and then see if Dr Leaf’s assertions about epigenetics and thoughts fit.

In order to do that, I need to briefly take you through some basic cell biology to establish some fundamentals, and then we will look properly at the science of epigenetics.

**BIOLOGY OF CELL DIVISION**

Our body is made up of cells. Cells are arranged in groups, which are called tissues. Tissues of different types cluster together to form organs, and multiple organs working together make up the body.

Cells in our body are constantly dying and are replaced by new cells. Each tissue has a number of cells whose job it is to divide to form new cells. In babies and children, cells are produced in a controlled way and more cells are produced than die, which provides growth. In an adult, the number of cells made roughly equals the number of cells that die, maintaining our function. In disease states and in normal aging, the number of cells produced can’t keep up with the increased loss of cells, and so our organs atrophy (shrink and shrivel).

The type of cell division required in this process of growth and maintenance is a form of copying, which is called “mitosis” (pronounced “my-toe-sis”). In mitosis, the DNA is preserved. Every new cell gets all 46 chromosomes, a full complement of DNA.

There is a different form of cell division that takes place when sperm cells and egg cells are made. Sperm and eggs are designed to meet together, so to ensure the new embryo only has 46 chromosomes, the sperm and the eggs go through a process of division called “meiosis” (pronounced ‘my-oh-sis’). In meiosis, each sperm or egg cell only gets 23 chromosomes, one of each pair of chromosomes, allocated at random.

The process of sperm production occurs all the way through the life of a man, from puberty until old age. Up to 120 million sperm are produced daily. It takes about 74 days for a sperm to reach maturity. Sperm that aren’t utilised are broken down after about 30 days [5: p975-6].

The process of forming eggs is completely different. A woman’s entire set of eggs is formed when she is still a foetus. At the time of birth, there are 2 million ova, but half of these are “atretic” (meaning: “deteriorated”). The degeneration of the eggs continues during development, and the number of viable eggs across both ovaries at the time of puberty is less than 300,000. Only one of these eggs reaches maturity per menstrual cycle (or about 500 in the course of a normal reproductive life); the remainder degenerate [278].

**CELL BIOLOGY OF GENE REGULATION**

All of our cells have the same DNA, but our bodies contain many different types of cells: nerve cells, liver cells, blood cells, skin cells, and many others. Different cells are made because different parts of the DNA code are utilised. Imagine an Easter Egg factory. There are different varieties of Easter Eggs, but the basic recipe and shape are much the same for all of them. The same basic set of instructions for shape and recipe will be used for all the eggs, but then there will be other instructions, one set of instructions for a different size of one variety, and another set of instructions for a different flavour of another variety.
In a similar way, cells share a similar basic structure and function, and will require the same basic DNA code for all cells. But the variety of cells, tissues, and organs require extra instructions that differ between the different types. Each different type of cell has certain sets of genes that are "turned on" or expressed, as well as other sets that are "turned off" or inhibited. They come about because these cells have distinct sets of transcription regulators. Some of these regulators work to increase transcription while others put the brakes on.

Normally, transcription begins when an RNA polymerase binds to a so-called promoter sequence on the DNA molecule. In recent years, researchers have discovered that other DNA sequences, known as enhancer sequences, also play an important part in transcription by providing binding sites for regulatory proteins that affect RNA polymerase activity. Regulatory proteins cause a shift in chromatin structure that promotes the reading of the DNA code. A more open chromatin structure is associated with active gene transcription.

Some regulatory proteins control multiple genes. This occurs because multiple copies of the regulatory protein binding sites exist within the genome. Consequently, regulatory proteins can have different roles for different genes, and this is one mechanism by which cells can coordinate the regulation of many genes at once.

**EPIGENETICS IN THE NORMAL CELL**

Epigenetics comes in to help with this process of regulation. Each of the three main epigenetic mechanisms changes the way the DNA interacts with the regulatory proteins, which help control the genes that are active or inactive.

DNA methylation is a chemical process that adds a methyl group to a specific DNA code sequence known as a CpG site. DNA methyltransferases (DNMTs) are enzymes that add the methyl tag. DNA methylation is used in some genes to differentiate which gene copy is inherited from the father and which gene copy is inherited from the mother, a phenomenon known as imprinting [279].

Histones are proteins that help DNA to wind into a tight bundle. Without histones, DNA would take up a lot of room. "Unraveled, the DNA contained in each cell would stretch nearly 2 metres, yet the DNA must fit inside the cell nucleus, a structure about 6 microns (six thousandths of a millimeter) in diameter. This is equivalent to stuffing 10,000 miles of spaghetti into a regulation-sized basketball." [280] Histones are modified in two ways, either by the addition of an acetyl tag or a methyl tag, to an amino acid called lysine. Methylation of a particular lysine (K9) on a specific histone (H3) is a common marker of gene silencing. In contrast, methylation of a different lysine (K4) on the same histone (H3) is a marker for active genes [279]. RNA antisense transcripts, noncoding RNAs, or RNA interference can also turn off genes.

What controls the methyl and acetyl tagging of the DNA strand and the histone complex? The answer is the activity of specific enzymes that catalyse the process. These proteins are themselves made by the machinery of the cell following the instructions of the DNA code.

**EPIGENETICS ACCORDING TO DR LEAF**

Dr Leaf refers to epigenetics a number of times, in the same style that she promotes all the science that she discusses. She writes that epigenetics is a new scientific breakthrough which shows that science is finally catching up with the Bible. The first evidence of DNA methylation was proposed in 1969, so it’s a bit of an exaggeration to call it a new scientific breakthrough. That aside, Dr Leaf writes in her prologue,

“What you are thinking every moment of everyday becomes a physical reality in your brain and body ... These thoughts collectively form your attitude, which is your state of mind, and
it’s your attitude not your DNA that determines much of the quality of your life. This state of mind is a real, physical, electromagnetic, quantum and chemical flow in the brain that switches groups of genes on and off in a positive or negative direction based on your choices and subsequent reactions. Scientifically, this is called epigenetics” (original emphasis) [2: p13-4].

So according to Dr Leaf, thoughts form attitudes, attitudes then become your state of mind, and thoughts effect the flow of every known substance or force, which switches genes on and off at will. She takes her fundamental assumption, “mind controls matter” and extrapolates: Thoughts control everything including epigenetic tagging, and since we also control our thoughts, we therefore control our own epigenetic code.

She follows on from this in the Introduction chapter, “How we think not only affects our own spirit, soul and body but also people around us. Science and Scripture both show how the results of our decisions pass through the sperm and ova to the next four generations, profoundly affecting their choices and lifestyles. The science of epigenetics (the signals, including our thoughts, that affect the activity of our genes) explains how this plays out.” [2: p24]

Again, the assumption that “mind controls matter” is key to her tangential logic: Epigenetic marks can be passed onto subsequent generations. And thoughts can control epigenetic marks. And the Bible says that God punishes the sins of the fathers to the third and fourth generation. Therefore our thoughts can be passed on to our great great grandchildren through epigenetics.

In chapter 3, Dr Leaf expands her theory via a full chapter on epigenetics. Her opening paragraph contains her fundamental assumption, “Our choices - the natural consequences of our thoughts and imagination - get ‘under the skin’ of our DNA and can turn certain genes on and off, changing the structure of our neurons in our brains. So our thoughts, imagination, and choices can change the structure and function of our brains on every level: molecular, genetic, epigenetic, cellular, structural, neurochemical, electromagnetic, and even subatomic.” [2: p55-6] That’s quite an expansive list. Dr Leaf doesn’t offer any evidence here about the validity of her all-encompassing statement; she just states it as truth.

She goes on, “... the science of epigenetics, which is tangible, scientific proof of how important our choices are ... This is because choices become signals that change our brain and body, so these changes are not dictated by our genes. Our thinking and subsequent choices become the signal switches for our genes.” [2: p56]

That’s a very brave statement to make. If thoughts really are the primary driver that switches our genes on and off, then perhaps Dr Leaf can explain what’s driving the signal switches for the genes of embryos, who don’t have any thoughts or make any choices. Plants don’t think at all, yet their genetic machinery and epigenetic tagging works just fine. Dr Leaf’s statement about the influence of thoughts on our genetic function is nonsensical.

In the next section, Dr Leaf attempts to clarify further, “The decisions you make today become part of the thought networks in your brain.” [2: p57] She then discusses the genetic code that we have in matched pairs of chromosomes, the assumption being that the decisions become part of the thought networks of our brain through genetic and epigenetic means. The data from our working memory that we sometimes perceive as our thoughts can also become part of our neural network, but only by the formation of memory. Memory is not dependent on genes or epigenetics any more than any other cellular process is, except for the more permanent forms of memory, which involve gene expression to make a protein needed to keep the neuron in an excitable state [281].
She summarizes with an overly simplistic model of epigenetics, “So methyl markers switch off genetic expression and acetyl markers switch on genetic expression. The ‘switching on or off’ is based on the signal, and we can choose to switch.” [2: p61] While it’s true that methyl markers of CpG islands of DNA are mostly associated with repression of gene activity (“switching off”), the DNA of some actively transcribed genes have been found heavily methylated, so methyl tags may do nothing at all [282], while methyl marking of histone proteins can switch genes off or on [272].

Even if we could influence the methyl tagging of our DNA and histones by our thinking, how do we have any control over which of the 30,000 genes we would be switching on or off, and in which of our trillion cells? Specifically tagging a specific gene sequence within a specific cell would be like tagging a single grain of sand in a sand box. So Dr Leaf’s statement about our epigenetic markers is overly simplistic, and there is no evidence that our thoughts control epigenetic markers.

The generational curse

Perhaps the most audacious suggestion that Dr Leaf makes is that epigenetics is the vehicle by which thoughts can pass down from generation to generation. She opens the next section of the chapter with, “Science has demonstrated how the thought networks pass through the sperm and ova via DNA to the next four generations.” [2: p57] Although when she says that “Science has demonstrated”, she actually meant, “Because Time Magazine said so”.

In the Time Magazine article “Why Your DNA Isn't Your Destiny” [283], several examples of trans-generational passage of traits are given. Most notable are those in roundworms or fruit flies. The agouti mouse described by the article, and tendered by Dr Leaf as evidence of epigenetic inheritance, were pregnant when fed the diet high in methyl group donor vitamins. The vitamin caused the gene to change its expression, but only for one generation, which is not an example of epigenetic inheritance, just a change in prenatal nutrition. This isn’t a new discovery, but is well documented and is a standard medical practice. Pregnant women have been using prenatal supplements for decades, like folate to reduce the risk of spina bifida, for example.

The article also discusses a study of generations of Nordic families and the association of their nutrition to the longevity of their offspring. Interesting for sure, and possibly evidence for imprinting, but we already know that correlation does not equal causation, so it remains to be proven if the Time magazine claims are robust.

Scientific mysteries?

Dr Leaf suggests that no one really understands why identical twins are not always identical, although she would have us believe that it’s their individual perception of the world that causes the difference [2: p58].

In truth, there really is no mystery. Those who hold that epigenetics is the key to genetic expression don’t tell you that the effect of genes on a person’s development is up to nine times stronger than epigenetics and environmental factors, depending on the trait in question. For example, Autism has a correlation between identical twins of up to 90% [284]. Of the remainder, epigenetics will account for some and so will other environmental effects.

Epigenetics is a complex pattern of markers that change rapidly without the same precision as DNA. Unlike DNA, which has one copying error in about 100 million base pairs, epigenetic tags have an error rate of one in twenty five [277]. The epigenetic tags undergo a process known as “epigenetic drift” which is the natural loss of the epigenetic tags at random parts of the DNA.
Epigenetic markers also affect different cells differently, and different tissues differently, depending on the timing of the environmental stimulus. For example, an epigenetic change of an embryonic stem cell will change the development of the embryo into a baby, and possibly an adult. An epigenetic tag of the DNA of a mature adult cell will only affect that cell [285]. How that plays out is going to differ wildly between individuals, even with the same genome. Most epigenetic marks don’t make any difference at all [277, 285].

Scientists refer to the epigenetic system as being stochastic in nature [72]. “Stochastic” means “having a random probability distribution or pattern that may be analysed statistically but may not be predicted precisely.” [3] Epigenetics is not particularly precise.

Nor is there solid evidence that epigenetics is intergenerational in humans. DNA is stripped of epigenetic tags as the sperm and ova are formed. So any epigenetic tag that’s formed is unlikely to make it through to the second generation, let alone the fourth. Kota and Feil confirm, “In the early germ cells, called primordial germ cells, the genomes are wiped clean of most of their DNA methylation and of other covalent chromatin modifications that are associated with somatic gene regulation, so that germ cells can acquire the capacity to support post fertilization development.” [286]

Coming back to the facts about the life-cycles of sperm and eggs that I discussed earlier, it’s clear that only epigenetic marks made after the development of the sperm would be passed on to the children. This limits the effects on generations of most epigenetic changes to the last 104 days. When eggs develop, most of them die, and the ones that do survive discard three quarters of their original DNA, which has already been stripped of its epigenetic markers anyway [286].

There is currently no evidence that how we think changes the function of the DNMT enzymes that write the epigenetic tags onto the DNA, nor the effects of the stress system. It’s a brave call to suggest that the mind is the epigenetic factor that switches genes on and off [2: p58-9].

**Choices and predispositions**

Dr Leaf further extrapolates by suggesting that the bad choices of parents go on to become the children’s predispositions because of epigenetics [2: p58-9]. But as I discussed before, if that were true, only bad choices made in the previous 74-104 days by the father could be passed down to curse the next generation, as that is the life cycle of a sperm.

In women, any specific epigenetic marker that could be passed on to her children would have to be made to the specific egg that was ovulated at the time of conception. Since there are about one million potentially viable eggs in the ovaries of a woman when she is born, the chances of a specific choice getting passed on literally becomes one in a million. But epigenetic markers don’t specifically target egg cells, so a single choice could affect any cell in amongst all the cells in a woman’s body, which blows out the probability to more than 100 trillion to one.

Based on probability alone, the change of a single choice being passed onto the offspring is so small that it is approaching zero.

What’s more, only some of the bad choices could ever be passed on, because of epigenetic drift, the high error rate in copying epigenetic marks, and the stripping of the epigenetic code when gametes are formed. The random, unpredictable nature of the epigenome doesn’t sound like a tool that would be used by a just, loving and eternally unchanging God.

Therefore, despite Dr Leaf’s bold claims, the suggestion that our bad choices or sins are passed onto our children through epigenetics is both bad theology and bad science.
In the section “Scientific Evidence of God’s Grace”, Dr Leaf writes, “Scientists have found that in a loving and nurturing environment, acetyl epigenetic markers increase on the genes in the hippocampus that keep us calm and peaceful. The more acetyl markers, the more these peace genes in the hippocampus express and dampen the stress response. A toxic choice produces the opposite effect: The acetyl markers reduce and the methyl markers increase, causing us to have less peace.” [2: p61]

Modern scientific findings show that Dr Leaf’s conclusions are overly simplistic. Wu et al [120] reviewed a number of studies which showed that stress in mice and rats actually increased histone acetylation, not decreased it, the opposite of what Dr Leaf claims. It should also be noted that the studies done on imprinting from maternal care, which Dr Leaf alludes to, showed changed to the epigenome from maternal care in mice and rats. The data does not relate to personal choices in humans. Dr Leaf’s conclusion is tenuous at best, and is not scientific evidence of God’s grace, unless she’s referring to the grace of God in rodents.

The ultimate ironic twist is that most epigenetic markers are dependent on genetic factors for their formation or the level of their expression [285]. So despite Dr Leaf claiming that epigenetics means we are not the product of our genes, the truth is that epigenetics is just as much dependent on our genetic expression as the rest of our biology.

**CONCLUSION**

Epigenetics is fundamental to life, changing the way in which the genes in our DNA are recruited or silenced. Even though it was first written about nearly 70 years ago, it’s still a relatively young field of research. There is lots of excitement about it, the “cutting edge craze” if you will. Epigenetics will be the key to a number of mysteries that current science still finds locked tight.

Dr Leaf assumes that all epigenetic markers influence generations to come, when in fact there are only a few examples in plants and insects, one or two in animals and none in humans. She makes a number of other broad and very bold claims about epigenetics to attempt to support her theories, which are not backed up by the current understanding of the science of epigenetics.

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**CHAPTER 13 – QUANTUM MECHANICS, NOT QUANTUM MYSTICS**

How good are your eyes?

I was once driving along a country road with my parents-in-law. My father-in-law was driving at 80km/h (just under 50mph in imperial) and from the passengers seat, my mother-in-law suddenly yelled out to stop the car. I was baffled as to why she walked back about 100 metres along the side of the road, then amazed when she returned and she showed me the two-dollar coin that she spotted (for those not acquainted with Australian currency, the Australian two-dollar coin is a small gold coin about 2cm across, the same size as an American nickel).

Even with eagle eyes like my mother-in-law, the best that an unassisted human eye can see is about 0.3 of a millimetre (from one metre away). The best that we can see with the aid of the most powerful electron microscopes is about 4 Angstroms [287], which is 0.0000000004 of a metre.

But the fabric of the universe is even smaller than that. Much smaller. Like, about $1 \times 10^{-33}$m, or about 0.00000000000000000000000000000001 of a metre. That’s the size of a
string, what is currently considered to be the most basic building block of electricity, light, gravity, matter, indeed, everything in our universe. As physicist and author Brian Greene described them, “Each of these strings is unimaginably small. In fact, if an atom were enlarged to the size of the solar system, a string would only be as large as a tree!” [288]

From the level of strings all the way up to about the size of an electron, particles are governed by a particular set of physical laws known as quantum physics. Quantum doesn’t mean “energy” as per Dr Leaf’s suggestion. As defined by physicists themselves, “Quantum” comes from the Latin meaning ‘how much’. It refers to the discrete units of both matter and energy that are predicted by and observed in quantum physics.” [289]

Dr Leaf refers to the principles of quantum physics a number of times in her new book, including a whole chapter dedicated to it. She refers a lot to principles of quantum physics as a justification of her theories on thoughts and free will.

Quantum theory is bizarre and at times, even hard for the trained quantum physicist to grasp. Richard Feynman, winner of the 1965 Nobel Prize for Physics, said, “I think I can safely say that nobody understands quantum mechanics”. So Dr Leaf may not be completely wrong when it comes to some of her statements about quantum theory. Unfortunately, she muddles up some basic concepts of quantum physics in her explanations, which doesn’t bode well for her conclusions about its more complicated facets. With some explanation around the basics of quantum theory, I hope that others will agree that Dr Leaf’s suppositions are not so assured.

THE FUNDAMENTALS OF QUANTUM MECHANICS

There are a number of basic concepts that make up quantum physics. This first part of the chapter is a cooks tour of quantum physics, a brief explanation of a subject that can take a lifetime to study. If you want to know more, I have included my sources of information at the end of this chapter.

Firstly, the Quantum. A quanta is “the smallest chunk into which something can be divided in physics. Quantized phenomena are restricted to discrete values rather than to a continuous set of values. Some quanta take the form of elementary particles, such as photons which are the quanta of the electromagnetic field.” [290]

Neils Bohr came up for the theory of quanta to describe the behaviour of electrons circling an atoms nucleus, which can only move within discreet, defined orbits. Not only can electrons only move in these specified orbits, but they also pop in and out of these orbits instantly. If an atom were like a solar system, the movement of electrons would be like Mars jumping onto Jupiter’s orbit and back instantaneously without traversing the space in between.

Then there is the wave-particle duality of light, and indeed, all other matter. As was first demonstrated by the double slit experiment, when light passes through a screen with a single small vertical slit cut into it, the light spreads out in all directions. However, light passing through a screen with two vertical splits results in what is known as an interference pattern (some areas with light and some with no light. It looks like a zebra-crossing). This proves that light has properties of a wave. However Einstein also demonstrated that light was a particle with the photoelectric effect. So photons of light are both a wave and a particle, but how the observer looks at it makes it one or the other. It could not be observed to be both simultaneously (a physics phenomenon termed “complementarity”).

The wave function (sometimes referred to as a “probability wave”) is, “a description of the probability that a particle in a particular state will be measured to have a given position and momentum. Thus, a particle (an electron, photon or any other kind of particle), when not
being measured or located, takes the form of a field or wave of probable locations, some
being more probable or likely than others.” [290]

This means that a photon will have a chance on being in one of a number of different
locations (as one example), and in quantum physics terms, the photon is in all of those
positions simultaneously before it’s measured. The measurement of the particles location is
said to “collapse” this wave function into one place. Where the photon is when measured is
related to chance (although can be described by the Schrödinger Equation)

This wave function doesn’t just apply to photons of light, but to all particles of matter.
Quantum physics declares that all particles and groups of particles - everything from atoms to
baseballs, through to the universe itself - everything has it’s own wave function, even human
beings. So therefore, technically WE are both waves and particles as well, and where we are
in space should also be related to chance, described by the Schrödinger equation.

As soon as a photon is observed or detected in a particular place, then the probability of its
being detected in any other place suddenly becomes zero. Up until that point, the particle's
position is inherently uncertain and unpredictable, an uncertainty that only disappears when it
is observed and measured. According to the Copenhagen Interpretation of quantum physics,
this act of observation by a conscience observer is the trigger that collapses the probability
wave function from many possible states to only the one observed.

Building from the wave/particle concept of matter, the Uncertainty Principle says that the
values of certain pairs of variables cannot BOTH be known exactly, so that the more precisely
one variable is known, the less precisely the other can be known. For example, if the speed or
momentum of a particle is known exactly, then its location must remain uncertain; if its
location is known with certainty, then the particle’s speed or momentum cannot be known.

Perhaps the most bizarre, and therefore one of the most poorly understood principles of
quantum physics is the concept of non-locality and entanglement. Subatomic particles that
are created together or interact with each other can become entangled. That is, their
properties become part of a quantum superposition (a superposition is that state in which their
probabilities have not yet been forced to declare themselves by observation, so the particles
exist in both possible states). If the entangled particles are then separated by any distance,
even the other side of the galaxy, it appears that the moment one is observed, it instantly
collapses the probability wave function of the other entangled particles.

In order for the wave function of a particle on the other side of the galaxy to know what
quantum state it’s collapsing to, the information needs to travel instantly, which means that
would need to travel faster than the speed of light. This is so counter-intuitive to classical
physics and Einsteins theory of relativity, which states that nothing in the universe can travel
faster that the speed of light.

This is a paradox, one which Einstein himself discussed in a paper known as EPR. A
physicist called John Bell described the theory of how to test it experimentally, and some
decades later, a then grad student called John Clauser completed the experiment.
Entanglement and non-locality (the simultaneous action on two particles separated by great
distances) were shown to be possible.

There are other explanations though, where some physicists maintain that nothing can travel
faster than the speed of light, and that the “instant” transmission of information from one
entangled particle to the other is either not occurring or occurs but doesn’t interfere with the
causality as the two observers have no way of influencing the experiment and thus not
violating the principle of causality (the Theorem of No Communication). There are also other
interpretations of quantum physics such as the Many Worlds hypothesis where every
possibility that could possibly take place occurs but each in an infinite number of other worlds within a multiverse.

So to try and succinctly summarise, quantum physics is the study of the properties of subatomic particles. It is described by a series of equations that prove that all matter is composed of subatomic particles, which all display aspects of duality that, until they are observed, remain in a superposition of a probability wave function. The act of observation is the trigger to the collapse that probability into it’s final observed state. The act of observation may also force any particles that are entangled with the original observed particle to instantaneously relinquish all other possibilities they may have had and collapse to the alternative state of the other particle, even if the entangled particles were light years away from each other, although there may not be any information transfer as that would not correlate with the Theory of Relativity.

Is your mind boggling? It’s a lot to cover in a small space, and I have tried my best to cram one of the most complex branches of science into a single page summary. If you’re confused by the topic, don’t worry, you’re in good company. Niels Bohr, one of quantum physics strongest supporters, once said, “Anyone not shocked by quantum mechanics has not understood it.” In truth, I find it hard to grasp myself, as do a lot of trained physicists. Even one of the most brilliant minds of our time, Stephen Hawking himself, said once, “When I hear about Schrödinger’s cat, I reach for my gun.”

Despite the laws of quantum physics being confirmed over and over for the last eight decades, physicists still argue about their interpretation and how to rationalise the truly bizarre aspects. The Copenhagen Interpretation is the most widely held by the physics community because it favours the pragmatic over the profound. But there are many equally compelling explanations and interpretations for the mysteries of quantum physics. They are beyond the scope of this chapter, but I have included a reading list for those who wish to study the subject further.

**DR LEAF’S INTERPRETATION OF QUANTUM PHYSICS - CLAIMS AND CORRECTIONS**

Throughout Chapter 7 of her 2013 book, Dr Leaf reinterprets the laws and concepts of quantum physics to explain her view of the world and set up some of her ongoing themes about thought and learning. However, some of her interpretations are incorrect, while others are nothing more than supposition.

As noted earlier in the chapter, Dr Leaf begins by stating that “‘Quantum’ means ‘energy’” [2: p104] when in actual fact, quantum simply refers to the smallest packets of matter that physics can study. Energy is part of quantum physics, but matter is the objective of study.

She says that, “particles move backwards and forwards in time and appear in all possible places at once.” [2: p105] However, particles do not time travel. There is much discussion about the concept of retrocausality that may arise from the concepts of entanglement and nonlocality, but its not accepted fact. And particles are not in all possible places at once. They can hold a superposition which is part of their probability wave function of that particle being in a part of space, but that doesn’t extend to everywhere. Otherwise how could an electron remain in the electron shell around the nucleus of an atom if it was simultaneously everywhere. The electron has a probability of being somewhere within the electron shell, but where exactly is not known until it is observed. That’s a huge difference to being everywhere simultaneously.

A few pages on, Dr Leaf states that, “Quantum theory calls entanglement “bizarre behavior” for particles - such as two entangles particles behaving as one even when far apart. Physicists
call such behavior nonlocal, which means that it is physically impossible to know the position and momentum of a particle at the same time. Another way of saying this is that there is no space-time dimension.” [2: p112]

Dr Leaf follows fact with fallacy here. Entanglement is bizarre, and the possible influence of one particle over another, even over massive distances, is called nonlocality. If she stopped there, she would be right. But the concept that it’s impossible to know a particles position and momentum at the same time is not nonlocality, but is called Heisenberg’s Uncertainty Principle. They are two different concepts entirely.

It’s a brave person who would try and contradict Einstein, and the entire discipline of the study of General Relativity and String Theory. But by going on to state that there is no space-time continuum, she directly opposes one of the fundamentals of modern physics. To put it in a different way, saying that there is no space-time continuum is like saying that the sun revolves the earth, or that there is no such thing as gravity. It’s nonsense.

Dr Leaf makes another nonsensical, contradictory statement when she writes, “One scientist even describes preons as twisted braids of space-time. If preons exist (which I think they do), they are unimaginably tiny and would have to fit inside a quark, which is currently the smallest known particle of matter, having a size of zero, and the strings are even smaller.” [2: p115]

So, Dr Leaf had just finished saying that there was no space-time continuum, but then quoted a scientist who said that preons were twisted braids of space-time. Which is it? Either there is space-time (in which case she proves herself wrong) or preons don’t exist. Physicists all go with the former – preons exist, as does space-time.

And since preons exist, they cannot “have a size of zero”. Strings cannot have a size of less than zero. It’s impossible for any physical object to have a size equal to or less than zero. 1x10^-33m is infinitesimally small, but it’s still greater than zero.

Finally, she claims, “Scientists say that our thought signals also seem to move faster than the speed of light and in ways that classical physics cannot explain” [2: p115]. Here, Dr Leaf suggests that observation and nonlocality are the same thing and that thoughts are the same as observation. But they are not. Observation brings decoherence. Decoherence collapses the probability wave function into a fixed state. Nonlocality causes the other entangled particle to surrender its probability wave function. Observation and nonlocality are separate functions.

Also, observation does not require thought, and thought does not require observation. For example, say two photons are entangled, and we perceive one as it strikes one of the cone cells in our retina. It’s converted into an electrical charge there and then. It has been observed, which causes decoherence. But as I discussed much earlier in the book, there are multiple steps of processing before that signal is incorporated into our conscious thought process. Our eyes perceive huge amounts of data, most of which is ignored by our neural processes so that only the important information makes it to the limited stream of thought. Thought can also happen separately to observation, such as visual imagery with the eyes closed, where we can “see” even though there are no photons actively being observed.

**Special mentions**

As I have shown, Dr Leaf’s interpretation of QM is fuzzy, at best. But there are other interpretations she makes that are also erroneous, but which deserve a special mention since she bases a large part of her theory on these interpretations.

**Quantum Zeno Effect**
One part of quantum theory that Dr Leaf discusses is the quantum Zeno effect. She states that, “QZE (the quantum zeno effect) is the repeated effort that causes learning to take place.” Further down the page she continues, “Basically, the QZE stipulates that your brain becomes what you focus on and how you focus.” (Original emphasis) However, the quantum Zeno effect is not related to learning at all.

Zeno was an ancient Greek philosopher who, amongst other things, formulated what is known as the Arrow Paradox. He wrote, “If everything when it occupies an equal space is at rest, and if that which is in locomotion is always occupying such a space at any moment, the flying arrow is therefore motionless.” George Sudarshan and Baidyanath Misra thought that the concept of an unstable particle that would never decay if its continuously observed was much like the arrow paradox, and so they called the concept the “Zeno Effect”.

Thus, the quantum Zeno effect refers to the prevention of decay of a quantum system, not the increase in information of a quantum system that learning would require. So already, Dr Leaf’s interpretation of the QZE contradicts accepted scientific facts. The remainder of the discussion, supposedly justifying her position on the quantum Zeno effect, amounts to a self-indulgent collection of anecdotes, and has nothing to do with modern physics.

If Dr Leaf’s interpretation of the QZE is so far off the concept defined by physicists, then what information did she use to devise her theory? Dr Leaf refers to one particular author in her citations, Henry Stapp, the main proponent of the QZE on cognitive states. Stapp contends that the mind holds the brain in a superposition of states using the quantum Zeno effect and that this phenomenon is the principal method by which the conscious can effect change within the brain. There is more evidence against this model than for it.

Rosenblum and Kuttner write, “How can a large, warm brain remain in a particular quantum state long enough for a person’s intentions to influence it? Stapp answers this with the ‘quantum Zeno effect.’ (Named for a Zeno-like claim: A watched pot never boils.) When a quantum system decays from an upper state to a lower, the decay starts very slowly. If it is observed very soon after the decay has started, it will almost certainly be found in the original state. The decay then starts over again from the original state. If the system is observed almost constantly, it almost never decays. Stapp applies this to the mental intentions “observing” the brain and thus holding it in a given quantum state for a sufficient time. Stapp cites various psychological findings as evidence for his theory. The theory is, of course, controversial.” [291: p191]

“Controversial” is putting it mildly. Georgiev was much more direct, “The central result of the current work is that the original exposition by Stapp (2007), Sec. 11.2, Figures 11.3-11.7 describing how the mind efforts can slow down environmental decoherence is erroneous and contradicts a basic quantum mechanical theorem proven in Section 4 according to which the von Neumann entropy production by the mind efforts is always non-negative. This result, taken together with our objections against the feasibility of paranormal Psi effects, implies that Stapp’s model does not have the potential to assist neuroscientists in resolving the mindbrain puzzle.” [292]

So it appears that Dr Leaf used an erroneous theory that contradicts quantum physics, then applied it in a way to neuroscience that’s further contradictory. Therefore the quantum Zeno effect has no bearing on thought or learning.

**Entanglement**

As I discussed in my “cooks tour” of quantum physics at the beginning of the chapter, quantum entanglement is truly peculiar. That two subatomic particles could remain linked despite being separated by great distances is beyond our normal rational understanding.
There are many pieces of evidence that support nonlocal effects, an effect that Einstein described as “spooky actions at a distance”. The Copenhagen interpretation stipulated that it was the act of measurement that forced decoherence, which if true would mean that particles would have to transfer information to each other faster than light speeds.

This is the aspect of entanglement that Dr Leaf focuses on exclusively. However, she ignores all other entirely plausible interpretations of quantum physics that don’t fit her premise, while risibly extrapolating the concept of entanglement, applying it to everything in nature.

For example, Dr Leaf says that, “The law of entanglement in quantum physics states that relationship is the defining characteristic of everything in space and time. Because of the pervasive nature of the entanglement of atomic particles, the relationship is independent of distance and requires no physical link. Everything and everyone is linked, and we can all affect each other.” [2: p110]

To categorically state that relationship is the centre of quantum physics fits Dr Leaf’s theories, but it is not a true reflection of the nature of matter as defined by quantum physics. For example, Nikolić writes, “there is a number of subvariants of the hard-orthodox interpretation that differ in the fundamental ontology of nature. Some of them are rather anthropomorphic, by attributing a fundamental role to the observers. However, most of them attempt to avoid anthropomorphic ontology, for example by proposing that the concept of information on reality is more fundamental than the concept of reality itself, or that reality is relative or ‘relational’, or that correlations among variables exist, while the variables themselves do not. Needless to say, all such versions of the hard-orthodox interpretation necessarily involve deep (and dubious) philosophical assumptions and postulates.” [293]

She also states that entanglement is a law of quantum physics, and while there are a lot of physicists that would agree with her, there are many other physicists that do not. Again, Nikolić summarises, “the fact is that, so far, there has been no final proof with which most experts would agree that QM is either local or nonlocal ... There is only agreement that if hidden variables (that is, objective physical properties existing even when they are not measured) exist, then they must be nonlocal. Some experts consider this a proof that they do not exist, whereas other experts consider this a proof that QM is nonlocal. They consider these as proofs because they are reluctant to give up either of the principle of locality or of the existence of objective reality.” [293]

So entanglement and nonlocality are principles that quantum mechanics is known for, but are still far from being officially being accepted as fact. At best, nonlocality remains a theory, and it is a brave call to say that the effect is pervasive.

The “ingenious” experiment

We’ll come back to the other part of Dr Leaf’s statement about the linking effect on everything and everyone in a different section. But I want to jump to some of her “proofs” that such quantum effects are provable. For example, she says, “An ingenious experiment set up by the HeartMath Foundation determined that genuine positive emotion, as reflected by a measure called ‘heart rate variability’, directed with intentionality towards someone actually changed the way the double helix DNA strand coils and uncoils. And this goes for both positive and negative emotions and intentions.” Dr Leaf’s describes the study as if it’s a revolution in scientific knowledge, but analysis of the paper itself reveals more speculation than revelation.

In chapter 11, I discussed how the HeartMath Foundation has a loose interpretation of what constitutes solid evidence, as demonstrated by their treatment of the paper on the electricity of touch [254]. Dr Leaf cited a summary report of the HeartMath Institutes research, a summary
that was published directly by HeartMath, not in an independent journal. In it, McCraty sets
the scene by outlining some basic science and assumptions, including HeartMath’s belief in
the electromagnetic field of the heart.

McCraty wrote, “Further studies conducted in our laboratory have indicated that the heart’s
electromagnetic field can be detected by other individuals and can produce physiologically
relevant effects in a person five feet away.” [294] Remember that ECG machines need special
filters and highly sensitive conductors in direct contact with the skin to pick up the hearts
electrical signal, and that MCG machines need superconductors and a magnetically shielded
room to pick up the hearts magnetic signal, which happens to be one billion times weaker
than the average fridge magnet. So it’s completely implausible that a person five feet away in
an unshielded room is able to detect anything other than background electromagnetic noise.
And since McCraty’s fundamental science is implausible, the rest of the study built on this
information can only be wrong.

He then outlines his group’s research, summarising the results of a much earlier paper. The
paper in question is titled, “Local and nonlocal effects of coherent heart frequencies on
conformational changes of DNA.” [295] It was presented at the 1993 conference of the US
Psychotronics Association, a group of fringe scientists who believe that “ESP is a natural
phenomenon” [296], and other unconventional theories. McCraty’s paper was never formally
accepted by, or published in, a peer-reviewed journal.

The research for the paper “Local and nonlocal effects of coherent heart frequencies on
conformational changes of DNA” involved ten members of the Institute of HeartMath, five
controls, and an unspecified number of “gifted healers” entering into a state of “deeply
focused love” while holding a beaker which contained a test tube of placental DNA in
deionized water, for two minutes per experimental run. The samples of DNA were then
analysed. The amount of UV light that passed through the solution was used as a measure of
how much the chains of DNA were wound or unwound.

The researchers claim that, “Individuals trained in generating feelings of deep love and
appreciation showed high coherence ratios in their ECG frequency spectra and were all able
to intentionally cause a change in the conformation of the DNA.” [295] They claim that the
effect was three times that of the control samples left alone in the lab. They also claim that
someone in a state of “deeply focused love” could affect the winding of the DNA from half a
mile away. They concluded that negative heart energy changed the conformation of the DNA
and some of the base pairs (the “steps” of the DNA “ladder”).

However, this paper is riddled with so many errors in their methods and analysis that it
couldn’t have proven anything at all.
1. They only had ten people in their pool of test subjects. The sample size is too small to
provide any meaningful analysis. They say that had “a number” of “gifted healers” but they
don’t define how many, or how they defined what constitutes a “gifted healer”, which
prevents analysis.
2. We do not know anything about the DNA to start with, other than it was placental and
suspended in deionized water. They say the samples were identical, but in what way? Were
they the same length, the same base sequence, the same number of chains? All of these things
can affect the final analysis.
3. They also heated the samples to start the denaturing process, to a temperature of 80°C,
which is way above normal body temperature thus negating any chance of applying their
results to a living system. And they don’t say for how long the samples were away from the
heat source before the samples were analysed, thus the heating and cooling could have been
the source of their results.
4. We don’t know how many samples they had or how many times the samples went through a heating and cooling process, so perhaps the increased denaturation was a result of damage to the DNA and not because of heart-generated intentions.

5. The results were averaged, but not statistically analysed because they didn’t publish p-values or confidence intervals. p-values are first year university material and are bread-and-butter of all scientific research for the last century. Any scientist with a shred of credibility would never publish results without a statistical analysis. Without such a basic analysis, there’s nothing to prove that the results of this paper were anything other than pure random chance.

6. They selectively chose which experiments they published (and I quote: “The data in figure 5 are the results of one such experiment” p4).

7. They found inconsistent results in terms of the time taken for the “effects” to occur. They assumed that energy can change the DNA, then waited until that change occurred, then concluded that the effect must the energy but that the results are complex and energy dependent. But by failing to measure the variable of this energy, there is no way of proving their hypothesis. In all likelihood, the changes were random.

8. Most of the curves that they graphed were so close to the control curves that their effect was likely due to chance. That goes for the negative heart energy analysis (figure 3), the three-for-the-price-of-one experiment (figure 4) and the proposed long-distance effect (figure 5).

So the paper describes a poorly conducted series of studies, without definition or measurement of key variables, missing information on the number of subjects and subject selection, and presenting a series of cherry-picked data curves which are so close to the controls as to be random, but with no basic statistical analysis to prove otherwise.

When they tried to explain the effects they believed had occurred, they first of all assumed that the heart was the source of the “coherent” energy that then influenced the brain. But they didn’t analyze the brain, so they couldn’t say for sure where the “energy” came from. The best they could come up with to explain the distant “effect” was some form of quantum entanglement. As we shall soon see, such a suggestion is not compatible with quantum physics.

In fairness, the summary of the work that Dr Leaf cites does contain some statistical analysis, but McCraty doesn’t show his data or how he arrived at his numbers. And even if the results are accurate, the sample was too small, and all of the other methodological flaws make it impossible to draw any meaningful conclusions.

A scientist should be able to recognise the critical flaws in the article. In no way did the paper prove that genuine positive emotion, directed with intentionality towards someone, changed the way the double helix DNA strand coils and uncoils, yet Dr Leaf promotes the paper as a trump card for her theories. Dr Leaf’s enthusiasm for this paper looks very bad for her credibility and reputation as a scientist.

**Mirror neurons**

Dr Leaf states later in the chapter that, “Through these (mirror) neurons we literally fire up activity in the brain without actually using our five senses through the normal sensory-cognitive cycle.” [2: p112] It’s an odd thing to say considering that mirror neurons normally fire off because of sensory input. Although if she meant that mirror neurons act outside of our thought processes, she invalidates her entire argument that only the mind influences the brain, since she admits that mirror neurons work outside the cognitive processes.

Dr Leaf also suggests that mirror neurons are proof that we are entangled with each other.
This statement, and the many others like it, such as, “Everything and everyone is linked, and we all affect each other” are not consistent with quantum mechanics. Let me explain why.

**Schrödinger’s cat**

When it comes to the behaviour of subatomic particles, quantum physics has never yet been wrong. But does quantum physics hold true for all things: atoms, molecules, proteins or people?

Erwin Schrödinger is one of the godfathers of quantum physics. In the mid-1920’s, Schrödinger described the wave functions of matter, which laid the foundation of quantum mechanics. Some physicists describe the Schrödinger equation as “the new Universal Law of Motion”, placing Schrödinger along side Newton in terms of scientific greatness.

But Schrödinger became troubled by the problems of quantum mechanics as it applied to our everyday world. The Copenhagen Interpretation of quantum physics suggests that particles are not physically present anywhere until they are observed. Since everything is made of subatomic particles, does that mean that nothing really exists until it is observed? To counter this absurdity, Schrödinger proposed a theoretical scenario, which has since become known as Schrödinger’s cat*.

Essentially, “Schrödinger’s cat” goes like this: Suppose an experiment was set up with two boxes. One box was empty. The other box contained a “hellish contraption”, consisting of a Geiger counter to detect particles, connected to a lever that opened a bottle of hydrogen cyanide gas. Inside the box was also a cat. Both boxes, the Geiger counter, poison and cat, are both independent and unobserved.

Now suppose that a particle was fired at a semitransparent mirror, meaning that it had a fifty percent chance of reflecting into the empty box, and a fifty percent chance that it would pass through the mirror into the box containing the Geiger counter, poison and cat. If the particle goes to the empty box, the cat stays alive. If the particle goes to the box with the “hellish contraption”, the particle activates the Geiger counter, which operates the lever, opening the cyanide, and the cat dies.

Quantum mechanics states that if a single particle was fired at the semi-transparent mirror, the particle can be in both locations at the same time - in the empty box AND in the box with the cat. The particle would only give its position if the system were observed. So until observation occurs, the particle is in both boxes, which means that the cat is both dead and alive at the same time. If there was a significant time delay (a few hours) between when the particle was fired at the boxes and when the result was observed, then quantum physics would say that the cat remains in that superposition state of being both alive and dead the entire time and only becomes either alive or dead the moment that you look in one of the boxes to observe the result. Such a situation is absurd!

Schrödinger’s cat is not without its critics. But this paradox has stood the test of time as a splinter in the side of quantum theory. It strongly suggests that, despite the uncanny ability of quantum physics to predict the behaviour of the subatomic world, it doesn’t hold true for our macroscopic world.

It’s not only the observer effect that breaks down at the macroscopic level, but entanglement as well. On the subatomic level, particles only become entangled when they significantly interact. In the lab, it takes complicated equipment to make two particles become entangled. Standard daily interactions do not create entangled particles sufficient to influence each other. Even if they did, the spin, momentum, position or whatever you are measuring is determined by probability. We only observe the outcome of that probability when we measure them. We
cannot force the particle into one form or the other. So even if we could entangle larger objects, we still don’t have any control over what happens at a distance other than forcing the particle out of its superposition.

Quantum prayer?

Prayer, then, does not work because we are entangled with each other in the quantum sense. Indeed, when studied by large scale, well-controlled experiments, the experimental prayer cohorts did not show any difference compared to the control group [297].

Dr Leaf outlined studies that she says prove the effects of prayer, but these studies have other confounding factors, such as social support, or the studies looked at faith overall, not just prayer. That faith is associated with better health and increased life expectancy is not in dispute. This has been shown a multitude of times, but again, there are many reasons for that, including better health choices (Christians are less likely to drink and smoke) and the social and community support that comes with church life.

Dr Leaf wrote that, “There are over twelve hundred studies linking intentional prayer and overall health and longevity. Meta-analyses in various medical journals have compiled results that show that intentional prayer significantly affect healing.” (Original emphasis) [2: p114] But she clearly exaggerated the number of studies on Christian intercessory prayer and their effects. For example, she cites Astin et al, whose meta-analysis was of all forms of remote prayer for healing, but of the twenty-three studies that were good enough to include, only five were of Christian intercessory prayer. Of these five, “Two trials showed a significant treatment effect on at least one outcome in patients being prayed for and three showed no effect.” [298] The same meta-analysis showed that Reiki and external qigong had more positive trials. The other “meta-analysis” that she cites was actually a three page editorial discussion by Jonas [299], not a meta-analysis at all.

On the surface this dearth of evidence looks bad for intercessory prayer for healing. On deeper analysis, there may have been confounding factors. For example, in the STEP trial, those in the control group (without prayer in the study) may have been praying themselves. Or perhaps the answer to prayer in those studied came outside of the study’s parameters. Perhaps God wants us to trust in him and his word - the raw power of faith - rather than in the science of a clean-cut clinical study that “proved” the benefits of prayer. It should also be noted that prayer is not an easily quantifiable substance, and neither is God for that matter. When God works supernaturally, he works super naturally, literally above the laws of nature. Perhaps prayer cannot be studied scientifically, since the scientific method relies on observing and controlling variables within the natural order.

Personally, I think God delights in performing miracles that are beyond our reasoning. The miracles of Jesus provide many good examples - he placed mud, made out of the mixture of dirt and his saliva, onto a blind mans eyes. He touched lepers to heal them. He told Peter to find tax money in the mouth of a fish. These sort of miracles perplex yet inspire us. Scientifically quantifiable or not, they still move us to worship the greatness of God.

SUMMARY

To summarise, quantum mechanics is a mind-boggling discipline of physics that has some bizarre concepts attached. On the level of sub-atomic particles, it has never been proven wrong. But because it’s so complicated, it’s also frequently misunderstood, and erroneously invoked to try and explain any number of bizarre theories. Dr Leaf is not the only author to fall into the trap.

Her explanations of entanglement, the quantum Zeno effect, and Heisenberg’s Uncertainty
Principle are inaccurate or have been disproven by physicists. She poorly explains the biology of mirror neurons, and grossly over-exaggerates the published evidence on the power of prayer.

It’s not that quantum physics could never explain a spiritual dimension. To my limited, conceptual understanding, String Theory and the Multiverse Theory hold great potential as a way of explaining the spiritual realm. But current understanding of quantum physics means that we still can’t claim that a spiritual realm is scientifically provable. For me, it’s still a matter of faith.

Rosenblum and Kuttner likewise caution us, “Classical physics, with its mechanical picture of the world, has been taken to deny almost all metaphysics. Quantum physics denies that denial: It hints at the existence of something beyond what we usually consider physics — beyond what we usually consider the “physical world.” But that’s the extent of it! Physics can certainly suggest directions for speculation. We should, however, be careful — in dealing with the mysteries of quantum mechanics, we walk the edge of a slippery slope.” [291: p154]

Quantum physics is definitely a space to watch into the future.

FURTHER INFORMATION

I found the following books and TV series and websites very useful in developing an initial understanding of quantum physics. They go over the concepts in a way that’s easy to grasp without needing a background in mathematics.


* Greene, B., Quantum Leap (Season 39, Episode 7), in Nova: The Fabric of the Cosmos 2011, PBS (First aired 16 Nov 2011)


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CHAPTER 14 – IN CONCLUSION

It’s time for a new paradigm.

For the last two decades, Dr Caroline Leaf has promoted the idea that toxic thoughts are the fundamental cause of our physical and mental health problems, and if we follow her teachings, we can detoxify our negative thinking and emotions and restore our health.

But that was the old way of thinking. Her concepts are based on superseded models of thought and stress. For the last fifteen years, new therapies have shown that you do not need to change your thought in order to change your behaviour, but you can change in spite of your thinking. Research has confirmed this. New models of stress show that stress is not always bad, but is both helpful and indeed necessary in order to experience a full and abundant life.

Unfortunately for Dr Leaf, the times have changed, but her teachings have not. Rather than develop her concepts according to the new discoveries being published, she has tried to adapt the new research to fit the old concepts. Rather than promoting truth, this has led to misinterpretation, and misinformation. She has tried to put new wine in old wineskins.
The work of Dr Leaf has not been without its positives. Many people attribute her work with helping them grow in life. For that, we should be thankful.

But it’s time to turn a new page, to start a new chapter, to move on from the old ideas and grow even more in the new knowledge that is available to us.

When all is said and done, I hope that this book will generate more discussion about mental health. I pray that we would all better understand, and be honest about, our own psychological wellbeing. I also pray that the Christian community, and the community at large, can better understand and support those who live with mental health issues on a daily basis. I hope that the opinions of psychologists, doctors, and neuroscientists are sought, and equally considered.

And I hope that, one day, the Christian community will lead the way in understanding, respecting, and caring for those with live with mental illness, just as Jesus did.

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APPENDIX A

DSM-5 DIAGNOSTIC CRITERIA FOR AUTISM SPECTRUM DISORDER

A. Persistent deficits in social communication and social interaction across contexts, not accounted for by general developmental delays, and manifest by all three of the following:

1. Deficits in social-emotional reciprocity; ranging from abnormal social approach and failure of normal back and forth conversation through reduced sharing of interests, emotions, and affect and response to total lack of initiation of social interaction
   a. Relative failure to initiate or sustain conversational interchange (at whatever level of language skills are present) in which there is no reciprocal to and from responsiveness to the communications of the other person
   b. Lack of shared enjoyment in terms of vicarious pleasure in other people's happiness and/or a spontaneous seeking to share their own enjoyment through joint involvement with others
   c. Markedly impaired awareness of others
   d. Lack of social-emotional reciprocity

2. Deficits in nonverbal communicative behaviors used for social interaction; ranging from poorly integrated verbal and nonverbal communication, through abnormalities in eye contact and body language, or deficits in understanding and use of nonverbal communication, to total lock of facial expression or gestures
   a. Markedly abnormal nonverbal communication, as in the use of eye-to-eye gaze, facial expression; body posture, or gestures to initiate or modulate social interaction (e.g., does not anticipate being held, stiffens when held, does not greet parents or visitors, has a fixed stare in social situations)

3. Deficits in developing and maintaining relationships, appropriate to developmental level (beyond those with caregivers); ranging from difficulties adjusting behavior to suit different social contexts through difficulties in sharing imaginative play and in making friends to on apparent absence of interest in people
   a. Failure to develop peer relationships as appropriate to developmental level

No or abnormal social play (e.g., does not actively participate in simple games; prefers solitary play activities; involves other children in play only as "mechanical aids")
B. Restricted, repetitive patterns of behavior, interests, or activities as manifested by at least two of the following:

1. Stereotyped or repetitive speech, motor movements, or use of objects; (such as simple motor stereotypes, echolalia, repetitive use of objects, or idiosyncratic phrases)
   a. Stereotyped and repetitive use of language or idiosyncratic language
   b. Stereotyped body movements

2. Excessive adherence to routines, ritualized patterns of verbal or nonverbal behavior, or excessive resistance to change; (such as motoric rituals, insistence on some route or food, repetitive questioning or extreme distress at small changes)
   a. Apparently compulsive adherence to specific, non-functional, routines or rituals
   b. Distress over changes in small, non-functional, details of the environment

3. Highly restricted, fixated interests that are abnormal in intensity or focus; (such as strong attachment to or preoccupation with unusual objects, excessively circumscribed or perseverative interests)
   a. An encompassing preoccupation with stereotyped and restricted patterns of interest

4. Hyper- or hyporeactivity to sensory input or unusual interest in sensory aspects of environment; (such as apparent indifference to pain/heat/cold, adverse response to specific sounds or textures, excessive smelling or touching of objects, fascination with lights or spinning objects)
   a. Hyper- or hyposensitivity to sensory stimuli, e.g., hyperacusis

C. Symptoms must be present in early childhood (but may not become fully manifest until social demands exceed limited capacities)

1. Abnormal development prior to age three as manifested by delays or abnormal functioning in social development, language as used in social communication, or play

Onset by 36 months


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FOOTNOTES

Chapter 2

* In the interests of full disclosure, I make no specific claim that this model is unique, although I’m unaware of other models incorporating all of these elements.

** We often describe rapid unconscious movements, especially to evade danger or to protect ourselves, as “reflexes”. Medically speaking, a true reflex is a spinal reflex, like the knee-jerk reflex. When a doctor taps the knee with the special hammer, the sudden stretch of the tendon passes a nerve impulse to the spinal cord, which is then passed to the muscle, which makes it contract. A true reflex doesn’t go to the brain at all.

*** A word of caution: While there’s good evidence that valproate increases the risk of autism, and a possible link between some anti-depressants and autism, that risk has to be balanced with the risk to the baby of having a mother with uncontrolled epilepsy or
depression, which may very well be higher. If you’re taking these medications and you are pregnant, or want to become pregnant, consult your doctor BEFORE you stop or change your medications. Work out what’s right for you (and your baby) in your unique situation.

Chapter 7
* Citation metric analysis performed using the “Publish or Perish” software application, which searches all available citations on Google Scholar and Microsoft Academic Search – see also http://www.harzing.com/pop.htm


Chapter 9
* The terms “Association” and “Correlation” tend to be used interchangeably.

Chapter 10
* I’m not sure if there is a less racist name for this game, but when I was a cub scout, we would sit in a large circle and the original message would be sequentially whispered from one boy to the next, each step degrading the message so that the end product sounded nothing like the original.

Chapter 13
* To borrow a physics term, this was a “thought experiment”. No cats were actually harmed!

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ABOUT THE AUTHOR

Dr C. Edward Pitt is a full time GP* and spare-time writer. He lives and works in the northern suburbs of Brisbane, Queensland, Australia. He is way too busy.

He has been studying and working in the medical profession since 1992. In that time he has gained the qualifications of MBBS (UQ) and the FRACGP. He spent a number of years in hospital paediatrics before getting sick of shift-work and moving into General Practice. Since attaining his GP Fellowship in 2005, he has gained experience in many and varied areas of medicine including Skin Cancer Medicine, Cosmetic Medicine, Aged Care, Sexual Health and Family Planning, and is a regular question writer and examiner for the Royal Australian College of General Practice.


He is also a husband, father to two rambunctious small boys, coffee connoisseur, try-hard leg spinner, amateur actor and a terrible dancer.

Whatever time he has left, he usually wastes it on Facebook!

(* GP is short for General Practitioner, also known as a Family Physician in some parts of the world)

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