How to Build a Healthy Brain

Reduce stress, anxiety and depression and future-proof your brain

Kimberley Wilson

www.yellowkitebooks.co.uk

First published in Great Britain in 2020 by Yellow Kite
An imprint of Hodder & Stoughton
An Hachette UK company

eBook ISBN 978 1 529 34851 4

Yellow Kite
Hodder & Stoughton Ltd
Carmelite House
50 Victoria Embankment
London EC4Y 0DZ

www.yellowkitebooks.co.uk

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Introduction

I grew up with an intimate knowledge of mental illness and neurodegenerative disease; multiple sclerosis, epilepsy, schizophrenia, motor neurone disease, Guillain-Barré syndrome, borderline personality disorder, antisocial personality disorder (sociopathy) and depression all run in my immediate family. This unusual introduction to the darker side of mental life set me apart from my peers. By the time I started school I understood what demyelination was, knew how to spot the signs of an imminent epileptic seizure and could explain the technical definition of psychosis. I understood deeply the fallout, for both individuals and families, when something goes wrong in the brain. But I almost certainly knew too much; I can still remember the rising anxiety I felt whenever I noticed a potential 'symptom' like pins and needles or an unexplained ringing in my ears. Was this the start? If you have watched the film *It Follows* you will have some idea of what I mean – a nagging sense that something was coming, and that it would get me eventually. Fortunately, I managed to sidestep any serious experience of health anxiety, but, in truth, it was not until I passed through my mid-twenties (75 per cent of psychological disorders develop by the age of 24) that I was able to relax. I was out of the woods.

Thinking back, it is no surprise that I became interested in psychology and mental health. In a bid to understand what was happening in the brains of those around me I embarked on my professional training. At the same time, to do whatever I could to protect my own mental health, I undertook additional training in nutrition and explored the other environmental factors that are known to increase an individual's risk of developing a mental or neurological illness. Psychiatry had long ago abandoned the notion that psychological distress had solely genetic causes, and evidence was growing about the influence of other factors, such as early life stress,

previous trauma and nutritional status, on brain (dys)function. I began synthesising that information into regular habits and principles that I could apply to my own life and those of my friends and family.

During my final year of training a study was published that made quite a splash in the field of psychiatry. Felice Jacka, an Australian epidemiologist, had found a correlation between overall diet quality and mental health in women. Women who had healthier diets – higher in fruit and vegetables, wholegrains, fish and unprocessed meat – were less prone to anxiety and depression. These common mental health concerns are the central focus of every psychologist's training and, with my own interest in food, lifestyle and risk reduction, I continued to closely follow this area of research (now called Nutritional Psychiatry).

After qualifying and becoming a Chartered Psychologist I began my career in what was then Europe's largest women's prison, HMP & YOI Holloway in north London. Around this time a Dutch study was published replicating the findings of a previous British study that showed that male prisoners were significantly less aggressive when they were provided with nutritional supplements (vitamins, minerals and essential fats) compared to a placebo. This was an incredibly important outcome with profound implications for prisons, prisoners and the criminal justice system. Knowing that aggressive behaviour (including acts of violence against others, self-harm and suicide attempts) was a major safety, staffing and financial concern for the prison, it seemed reasonable to consider improving the (very poor) quality of the food in the establishment, or looking into supplementation, to see whether there would be any effect on violence and aggression. Unfortunately, my efforts did not lead anywhere.

When I stopped working for the prison service and established my own clinic, I decided that I could at least make this valuable information available for my clients. Food and lifestyle have profound effects on brain health, mood and behaviour. This, I believe, is public health information that *everyone* should know.

As a psychologist with my own clinical practice, and from my own history, I see the terrible damage that psychological illnesses can wreak. I have committed myself to helping my clients to recover and reclaim their lives

from these conditions, but over the years I have found myself increasingly frustrated by two things:

1. For many people therapy simply isn't enough – mental health is influenced by so many important lifestyle factors that occur outside of the consulting room.

2. Even when I can make people aware of these other issues, I can only see one person for one hour at a time. What about all the people on waiting lists or who haven't yet made it to the doctor to ask for help?

I realised that there is a big gap between what scientists are discovering and what the public is being told about the power we have to influence the impact of these illnesses. There is also little awareness of the importance of taking care of our brains more generally, not just to prevent illness but to improve performance, including having better attention, faster reaction times and improved memory.

This book is designed to bridge those gaps. I want to help you understand that brain health should be a priority for us all and that there are practical habits and exercises you can start using *right now* that will help to improve your brain health and function. In this book I will outline the best available evidence for how you can modify your own lifestyle to improve brain health and reduce your risk of cognitive decline.

Don't wait

One of the most common mistakes that people make in relation to managing their emotional and mental health is waiting until there is a crisis before they act. In part because of the stigma that still pervades mental illness, along with the limited availability of evidence-based, practical information, people feel that they should just 'push through'. But that's the equivalent of waiting for your teeth to fall out before making an appointment with the dentist.

How to Build a Healthy Brain is my manifesto advocating for the practice of *prevention* in mental health in the same way that we do for physical health conditions. Fortunately, many of the habits that help to promote

physical wellness – such as safeguarding sleep, engaging in regular physical activity and eating nutrient-dense foods – also support mental health and resilience. Doing what you can to adopt some of these practices is a great start. However, there are also important differences. Much of our psychological health relates to our capacity to understand and manage our emotions and the quality of our relationships – features of mental health that receive too little attention. This book outlines the evidence base for which psychological activities and attitudes have been shown to protect mental health and reduce the risk of mental illness, and provides practical, actionable steps to help you get started.

How To Use This Book:

The chapter 'A Quick Note on Research' is designed to help you navigate your way through the myriad health claims in the media, giving you the skills to tell fact from fiction. 'Getting to Know the Brain' is a whistle stop tour of the brain and neuroanatomy, that will help you get the most out of this book. If you want to get straight to the good stuff you can go directly to Chapter 4.

I begin by introducing the two crucial aspects of brain health. I call these the 'major players'. Balancing these two factors is the key to tipping the balance in favour of better brain function, both in the short- and long-term. From there each chapter describes how individual lifestyle habits control or influence the major players. By the end of the book you will understand the best-known risk factors for brain health and will have discovered how to reduce or reverse them. Each chapter ends with a list of practical 'takeaways' – tips and actions that you can start to implement immediately – and there are also a few quick questionnaires along the way. These will allow you to assess where you currently are in your process of building a healthy brain, and where there are areas for improvement.

Dementia does not have to be an inevitable part of ageing. In fact, a paper published in 2019 found that older people who followed healthy lifestyle advice, as outlined in this book, had a 30 per cent reduced risk of

developing dementia, even when they carried genes that put them at higher risk. And there is no need for expensive superfood powders or mountain retreats; most of these effective tools don't cost any money and take very little time.

Taking mental health prevention seriously means being *proactive* in establishing practices that can reduce the risk of psychological decline, addressing stress as soon as possible, and avoiding substances and activities that harm the brain. This book presents some of the latest and strongest evidence available about how to do that. However, it is important to note that risk reduction is not the same as risk *elimination*. A percentage of what happens to our health is down to luck. Some people can live pristine lifestyles and still develop illness. Nonetheless, the science is clear that we can reduce our risk of developing common mental health concerns, such as depression and Alzheimer's disease, by adjusting lifestyle behaviours and the more people adopt protective habits the more they will stave off or delay developing these illnesses.

Having a healthy brain is the key to enjoying a full and satisfying life, increasing our abilities, performance, creativity and our sense of life satisfaction. Throughout this book I hope to empower you with both the *why* and the *how* of better brain health and emotional resilience. I want to help you to have a stronger, more resilient brain, so turn the page and let's get started!

CHAPTER 1

The Global Burden of Mental Illness

There is a great deal of discussion in the media about the rise in non-communicable or 'lifestyle' diseases and the urgent need for effective policies and treatments to end this trend. But which disease is the leading cause of disability across the world? Diabetes? Heart disease? These are both good guesses. But the answer is actually depression. This means that more people suffer impairments in daily functioning – such as attending school and work, and enjoying social relationships – because of depression than illnesses like cancer or stroke. In only 10 years depression will be the *leading* cause of global disease burden – a measure of how much an illness affects quality of life, life expectancy and the economy.

Depression is a term for a group of overlapping symptoms that together significantly impair a person's mood and ability to function. Depression is often thought to be solely an illness of the brain, but it actually leaves its mark throughout the body and is characterised by a range of psychological, physical and interpersonal symptoms:

Psychological

- persistent low mood or sadness
- feelings of hopelessness and helplessness
- low motivation
- loss of interest in things that were formerly pleasurable
- low self-esteem
- tearfulness
- feelings of guilt
- irritability
- impaired decision-making
- anxiety

- thoughts of self-harm or suicide

Physical

- sleep disturbance
- appetite or weight changes
- gut symptoms
- lack of energy
- slow movements and/or speech
- aches and pains
- loss of libido
- changes to the menstrual cycle
- self-neglect

Interpersonal

- poor functioning or performance at school or work
- social withdrawal
- relationship difficulties

We have had effective drug treatments for depression since the late 1950s so why is depression a growing global problem? Frustratingly, our current modes of treatment (typically antidepressant medication and/or talking therapy) are not as effective or accessible as we need them to be. As the number of people being diagnosed with depression has grown, so have the prescriptions for antidepressants. Yet more than half the people taking antidepressants in the UK have ongoing symptoms. This discrepancy between the first-line treatments and residual symptoms has led to a rethink about what causes depression and, therefore, how it should be treated. It's not that medication is not a valuable tool, but perhaps we have been so focused on it that we have forgotten to check what else might be in the toolbox. On top of this, across the country, mental health departments are short-staffed, services are being closed and helplines shut down, meaning that talking therapy, an effective treatment for depression, is inaccessible for a growing number of patients.

There is now robust evidence from human trials that certain lifestyle factors – our daily habits and activities – can help to prevent depression

from developing or reduce its severity. Many of these factors are cheap, or free, and can be implemented immediately. I have written this book to give you access to this research and practical tools to turn the evidence into easy, everyday habits.

Young people

In Western countries depression is directly linked to the second largest cause of death in young people. After accidents, the major cause of loss of life in those aged 15–29 is suicide, which is typically driven by depression. Sadly, rates of depression and suicide in young people have increased faster over the last 15 years than at any point since records began. There are some important questions being asked about what has caused this sudden rise in the levels of distress that young people are experiencing. The answer appears to be a combination of environmental, social and lifestyle factors that undermine physical brain health and psychological resilience. We will take a closer look at several of these factors throughout this book.

Older adults

What about later in life? In the last few years, dementia (including Alzheimer's disease) became the leading cause of death in the UK. In 2017 the World Health Organization estimated that there were 47 million people living with dementia across the world. By 2030 that figure will jump to 75 million. A new case is diagnosed every three seconds.

Dementia is the name for a group of devastating age-related neurodegenerative disorders. In these illnesses, over a period of many years, brain cells begin to break down and die, creating lesions (gaps) in the brain tissue. The sufferer progressively loses cognitive function, particularly in domains such as memory and decision-making. There is currently no cure for dementia. In fact, some of the world's largest drug companies recently abandoned development of dementia drugs due to lack of efficacy in clinical trials. Again, this is leading many in the field of neuroscience to re-evaluate previous assumptions about the causes of dementia, opening up new avenues for research and intervention.

That said, in the world of medicine it is already common knowledge that

dementia *is not an inevitable part of ageing*. A recent review by *The Lancet*, one of the world's most respected scientific research journals, estimated that, if we carefully followed the best lifestyle advice, we could prevent up to a third of global cases of Alzheimer's. That translates to up to 15 million fewer people being struck down by this terrible disease.

If one in three cases of Alzheimer's disease could be prevented or delayed with improvements to lifestyle and daily habits, why isn't this crucial information easily available to the public? Why don't more people know about it? A recent survey found that while nearly half (42 per cent) of UK adults say that dementia is the disease they fear most, only 34 per cent thought that you could reduce your risk and only 1 per cent could name the seven known risk factors (smoking, high blood pressure, diabetes, obesity, depression, lack of mental stimulation and physical inactivity). The lack of committed and comprehensive investment in a public health campaign for the brain leaves our communities even more vulnerable to these life-shattering illnesses.

The Growing Mental Health Crisis

There is a long history of the brain and mental health being short-changed in comparison to physical health. Despite being some of the most significant causes of disease burden in the world, mental health research is still woefully underfunded. I know from personal experience as the former manager of a National Health Service (NHS) mental health facility that, when budgets are cut, mental health provisions are first in line for the chop.

When we look at the prevalence of mental illness, the growing rates of diagnosis, the restrictions on access to treatment and the protracted recovery, this 'mental-health-last' approach makes very little sense. A report by one of the UK's largest mental health charities found that 40 per cent of visits to a general practitioner (GP) involve mental health concerns. A separate NHS report showed that mental illness (including anxiety and stress) is the number one reason people take sickness leave from work and, when they do, they are off for longer periods than for physical

conditions.

This wide-scale favouring of physical health over mental health also ignores the fact that mental health conditions often have significant physical symptoms, as listed on page 8. This means that when someone goes to their GP for stomach problems, back pain or fatigue, both doctor and patient may be erroneously engaged in looking for a physical cause for an illness when it is in fact a psychological one. Failing to hold the brain in mind causes delays in identifying the true cause, and the right treatment, for many patients.

One of the reasons for the disparity between how mental health conditions are treated in comparison to physical illness is the erroneous belief that mental health conditions are not 'real', that they are solely a problem of psychology and not biology. It's so important to remember that the brain is an organ; it's just an incredibly complicated one with some very special functions. For example, we all know that for our heart to work properly we have to look after it by eating well, exercising, avoiding smoking, and so on. A heart that is not properly cared for will begin to show impairments in its function through changes in blood pressure, palpitations and pain. These are the clues that our heart needs some extra attention. The same principle applies to the brain. A brain that is struggling will begin to show impairments in its functions; it just so happens that the brain's functions are mood, personality, planning, decision-making, information processing and memory. These are the clues that the brain needs some extra attention, but too many people brush these symptoms off as incidental or, worse, something to be ashamed of and ignored.

The idea that mental illness is somehow 'less real' than physical illness doesn't make us stronger. In fact, quite the opposite. We know that recovery from mental health conditions is best if you intervene as early as possible, during the first episode or when symptoms are mild. However, the misunderstanding and stigma around mental illness means that people sit on their symptoms of brain distress for weeks, months, and sometimes years. By the time the symptoms are bad enough for them to seek professional help, the illness is much more entrenched and more difficult to treat.

It is, unfortunately, no exaggeration to say that we a facing a global mental and brain health crisis. I cannot state this more clearly: across the lifespan, from the young to the elderly, *the leading causes of death and disability are illnesses of the brain and mental health*. As well as the rise in depression, in the UK there was a 14 per cent increase in Alzheimer's deaths between 2016 and 2017. And scientists have dismissed the suggestion that this is simply because we are living longer: not only are more people affected, but these conditions are affecting people earlier in their lives than ever before. Alongside this the number of people living with severe mental illness is growing; more people are being detained under the Mental Health Act and around 1 in 10 children now has a diagnosable mental health condition. Something is profoundly wrong. There is something – or many things – about the way that we are living, the way that we are neglecting our brain health, that is putting us all at greater risk. For me, it is simply not enough to say that someone is depressed or that they have insufficient serotonin available in the brain. These statements are descriptive but they don't tell us anything about *why* this is happening and, importantly, what we might be able to do about it – how we get to the root cause of this dysregulation.

How to Build a Healthy Brain brings together the latest research on the known, modifiable risk factors for mental illness and neurodegeneration, helps you to understand the science and empowers you with effective, practical tools to start improving and protecting your brain health today and for years to come.

CHAPTER 2

A Quick Note on Research

It is impossible to open a newspaper or read an article nowadays without coming across a piece of apparently groundbreaking health research that claims to extend or enhance your life. If a lot of the time that information seems contradictory, that's because it is, but that usually isn't the fault of the researchers; it's down to the new way that we consume our news.

In the 'olden days' (before the year 2000!) newspapers and a handful of TV news programmes had the monopoly on how we acquired our information. All news had to be accessed from a finite number of daily editions or broadcasts. If a news story broke after the *Ten O'Clock News* or the evening edition it might appear on the radio but otherwise we all had to wait until the next publication cycle to find out what happened. On top of that, these outlets had a small number of gatekeepers; editors or science journalists who had the final say on what got written about and published.

As the world moved into the digital era that old model started to fade away. News websites could be updated in seconds and a deluge of dedicated news channels suddenly had hours of airtime to fill. This technological shift caused a change in the function of news: where in the past the news was a 'service', today it is better described as a 'market'. Most of the major news websites are funded by advertising, a revenue model that depends on capturing as many eyes as possible. In this highly competitive news market clicks mean everything, so editors have to find a way to make their content as compelling as possible. Psychologically, the best way to capture someone's attention is to appeal to their emotions and, because we evolved to rapidly respond to threat, editors spin headlines to create as dramatic-sounding a story as possible.

I have spoken to many researchers and journalists who felt unhappy about the headline that was applied to their study or story. It is also very

common for research that has only been conducted on mice or even on cells in a cell culture dish to be published as though the results apply to humans. Often you have to read through several paragraphs (most people don't) to discover that the story pertains to a mouse mother fed large amounts of caffeine and not human mothers drinking coffee, for example.

For their part, the editors are simply doing their jobs – getting as many people as they can to click on their story, securing revenue for the company. However, the result for the consumer is an unhelpfully confusing array of dramatic news stories with advice that seemingly changes by the hour. This doesn't just leave the reader unsure of what to believe, it makes us doubt the validity of scientific research altogether. This is, of course, hugely unfair on the researchers who work hard to conduct high-quality research, but also does a disservice to the public who rely on these outlets to translate and disseminate the gems of really useful information hidden within hard-to-access scientific journals or overshadowed by a sensationalist headline.

The role of social media

There has been another addition to the information landscape that makes navigating the health and wellness space even more perilous: social media. Social media platforms such as Twitter, Facebook and Instagram have fundamentally changed the way we consume information. For the most part this is of huge benefit to humanity. The speed with which stories, videos and petitions can now be shared has provided new outlets for social justice activism, disaster intervention and financial aid. It has also changed the way in which we access health information with people turning to bloggers and lifestyle influencers for their health information. A recent PWC Health Institute report found that 90 per cent of young people believe the health information they find on social media. However, unlike registered health professionals, many of these people are unqualified, have not been taught to read and interpret scientific data, and are not bound by professional codes of ethics and practice. This means that, even with the best intentions, they may be disseminating unreliable or false information to their hundreds, thousands, perhaps millions of followers.

Following bad health advice can have serious consequences. Wellness blogger Belle Gibson was able to amass thousands of followers and hundreds of thousands of dollars falsely claiming that she had cured terminal brain cancer with a plant-based diet. Who knows how many vulnerable people followed her example before the truth came out? Thousands of social media accounts promote a range of health 'treatments' for which there is absolutely no scientific evidence, such as the alkaline diet for cancer or celery juice as a panacea. In 2018 an American court awarded $105 million in damages to a woman who was encouraged to eschew conventional cancer treatment in favour of an 'alkaline-based' treatment. Her illness is now terminal.

Fortunately, increasing numbers of researchers and healthcare professionals are now taking to posting their research directly on their own social media pages, allowing them to explain exactly what they found, what it means and to whom it should relate. This was the reason that I decided to move my own social media presence away from the occasional picture of my lunch to a mental health resource where I explain and share research on mental health, psychology and Nutritional Psychiatry. Increasingly, publications and influencers are seeking out the advice and opinions of qualified experts, which will help to reduce confusion and keep consumers safe. That said, it is also important that consumers are able to think critically about the information they are presented with and what someone means by 'evidence'.

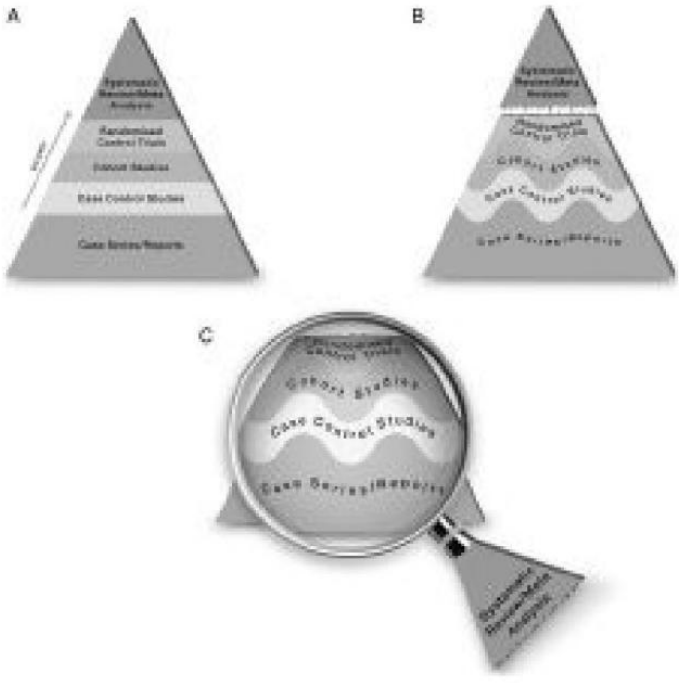
Not All Research is Created Equal

The scientific method attempts to refine our notions of 'truth' by testing assumptions under rigorous conditions, and there is an established process to move from an idea (hypothesis) to accepted knowledge and treatment. Let's imagine I am an eighteenth-century doctor called Edward Jenner and I have a hypothesis that people who have previously been exposed to cowpox (found in cattle) develop immunity to smallpox. Smallpox was at the time a highly contagious and deadly viral disease

(happily it has since been eradicated through successful vaccination programmes) and it would be extremely valuable to understand whether being infected with the milder cowpox virus could protect people against the more dangerous smallpox. As the person proposing the hypothesis, in strict scientific practice, it is my responsibility to disprove it. The scientific method tasks me with doing everything that I can to prove myself wrong and, if I cannot, then I can say that my hypothesis is supported. Notice that I didn't say 'proven'. This is because there is always the chance that there is a piece of contradictory or interfering information out there that I (or others) haven't yet come across. In this way the scientific method always leaves room for new and better evidence.

If you have read any scientific articles yourself, or have listened to interviews with researchers, you will have heard the speakers use a lot of language that makes it seem as though they are unsure of what they are saying. The results always 'suggest' or 'indicate' that an idea 'may' be 'supported'. It may sound as though these scientists are hedging their bets but this language is actually a reflection of scientific rigor and intellectual honesty. They will be confident of what they found but the principles of the scientific method mean they are leaving space for the outcomes to be refined by future research.

Not all evidence carries equal weight when it comes to quality, authority and generalisability. In evidence-based medicine (EBM) the 'hierarchy of evidence', usually depicted as a pyramid, ranks the quality and strength of scientific evidence:



(Source: Murad, M. H., Asi, N., Alsawas, M. and Alahdab, F., 2016. New evidence pyramid. *BMJ Evidence-Based Medicine*, *21*(4), pp.125–7)

Case reports

At the base of the pyramid are case reports – observations from individual practitioners on individual patients/cases. They are often interesting to read because an experienced clinician is in a good position to notice unexpected or novel outcomes of a

treatment or intervention, cases that buck the trend or contradict the current paradigm. However, because case reports relate to individual observations that have simply emerged in a one-off situation, they cannot account for any unique factors of the practitioner, patient or environment that might have an influence on what is being observed. For example, what if whatever is being observed was just an accident? Case reports can help us to develop hypotheses that can be rigorously tested higher up the pyramid.

Mechanism studies

In *in vitro* studies, cell or tissue samples are exposed to the substance being tested. So I might take some human immune cells and expose them

to the cowpox virus. I could then test how these immune cells respond when they are later exposed to smallpox. If they were able to fend off the smallpox virus I would have my first piece of evidence that, at least on a cellular level, there was a relationship between cowpox exposure and smallpox immunity. But events that occur on a cellular level do not always translate on a systems level. Systems are much more complex than individual cell activity and there could be hundreds of other factors in a system that interfere with the action we have observed in the cell culture dish.

Animal models

Animal models give researchers a clearer sense of the nature of the interaction between an active compound and a live biological system. Commonly, experiments will be conducted with mice or rats that have been specially bred to exhibit a murine (mouse or rat) version of a human illness such as Alzheimer's disease or multiple sclerosis. Animal research illuminates the biological mechanisms that might be involved in a disease action when it is not possible to conduct the research with human participants.

It is worth saying that scientists have to apply for stringent ethical permission before they start conducting experiments with animals. In their ethics applications researchers have to clearly explain how they will care for the animals and demonstrate that they have considered all ways in which they will limit the animal's distress during the trial.

At the top of the pyramid are randomised controlled trials, systematic reviews and meta-analyses.

Randomised controlled trials

Randomised controlled trials (RCTs) are considered the gold standard in EBM research because of their ability to reduce the opportunity for bias within the study protocol, and for quantifying whether a drug or intervention is more effective than doing nothing, administering a placebo or regression to the mean (the tendency for most unusual results to drift back to normal levels without intervention). Typically, in an RCT participants are randomly

allocated to either the active arm of the trial (where they receive the real treatment) or the placebo condition (an identical but inactive intervention). For example, 100 people volunteer to participate in a vaccination trial. Fifty will be randomly allocated to receive the vaccine and 50 will get the placebo, such as an injection of saline that will have no effect on immunity. Importantly, neither group will know whether they are getting the real treatment or not, and ideally neither would the nurse administering the injections. They are then exposed to the live virus and assessed for how many from each group go on to develop the infection.

At this stage researchers are in a position to say whether one thing *causes* or has a direct effect on another in particular groups of people.

What if we're not testing a drug? When it comes to lifestyle habits it is incredibly difficult to prevent people knowing whether they are in the active or placebo condition of the trial, especially in nutrition studies. Researchers in these fields have to work incredibly hard to design RCTs appropriate to what is being studied.

Also, when studying lifestyle, we can make the general assumption that the activity or behaviours (e.g. exercise) are not toxic, therefore rather than safety, lifestyle intervention trials will look at efficacy; what combination of which behaviours over what period of time will have a positive or negative effect on a target health outcome?

Systematic reviews and meta-analyses

Evidence from RCTs can tell us about causality but, strictly, results are still confined to the population on which it was tested. It is not uncommon, for example, for research to be conducted on small groups of a particular population, such as white, male university students. This is often an opportunity sample (most research labs are parts of universities) but it means that researchers risk overlooking features that are specific to women or people of other ethnicities, for example.

Systematic reviews and meta-analyses allow the results of several small trials to be pooled together to look for overall trends. This can give us more confidence that the results that were observed can be generalised to large populations rather than small idiosyncratic groups. This is, of course, really

CHAPTER 3

Getting to Know the Brain

Imagine you are walking down the street listening to music. Your brain is interpreting the information coming in from your eyes about the conditions of the pavement. Is it gravel or paved? Is there a lamp post coming up that you need to avoid? It is then coordinating this information with the sensory data coming in from your feet and legs, and making judgements about how much pressure to apply to the ground, and how and when to bend or extend your knees. Specialised areas of your brain will be holding in mind your destination and what you expect to happen when you get there. At the same time the tiny vibrations created by the soundwaves as they hit your eardrums are translated into electrical signals that will be further interpreted into music or words. Receptors in your skin relay information about the air temperature and your brain makes a decision about whether you should button up your coat or take off your scarf to help regulate your internal body temperature.

At the same time a vast network of messages are being exchanged about other important internal conditions. The relative availability of water or glucose in the blood will translate into a conscious awareness of thirst or hunger. The accumulation of certain molecules in the brain translates into varying degrees of alertness or a desire to sleep. Interoception – the perception of what is happening inside the body – will indicate hunger, satiety or the need to pee.

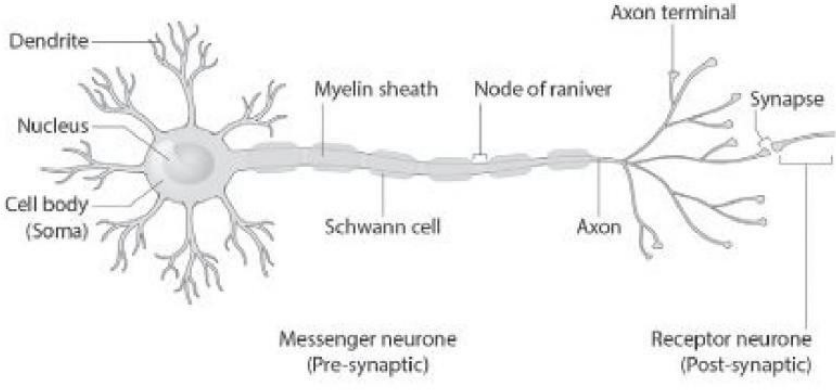
This activity doesn't stop when you close your eyes and go to sleep, far from it. As your brain moves through the different levels of sleep (see page 69 for more on this) it begins the nightly process of reorganising the events of the day. Important details and information are encoded while insignificant ones are archived or allowed to fade. Furthermore, during sleep your brain undergoes a deep clean, clearing away the accumulated debris of the day,

helping to keep your brain healthy.

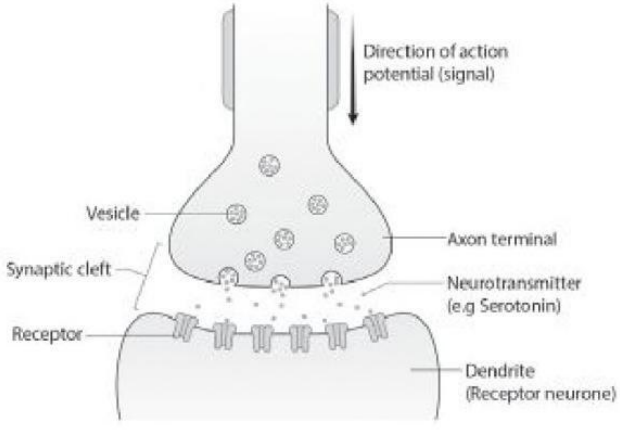
The human brain is the most complex structure in the known universe. This is why it always astounds me when people expect themselves to completely understand their own minds. Most people don't understand their phones, so why would you expect yourself to understand an organ that is many hundreds of times more complex? Nonetheless, it will be helpful for you to know a little bit of neuroanatomy to get the most out of this book. That way, as you move through the chapters, you will have a better sense of the physical actions that all the tips and habits are exerting on your brain. And you will better understand why it is all so important.

Brain Cells

Motor Neurone



At The Synapse



As the action potential travels along the axon, it triggers vesicles (sacs

containing the neurotransmitter) to fuse with the synaptic membrane. The neurotransmitter is released and drifts across the synaptic cleft where some dock to receptors, triggering a new action potential. Some of the neurotransmitter drifts back to the presynaptic neurone where it is replaced/re-uptaken.

There are several types of cell in the brain, each playing an important and complementary role to the other. The type of cell that most people are familiar with is the nerve cell or 'neurone'. Neurones are couriers in the brain system; they are responsible for relaying messages to and from the brain and the body.

Neurones have a 'soma' or cell body that contains the nucleus. The nucleus contains the cell's DNA – the packet of information that tells the cell what to do. The branch-like projections, 'dendrites', receive the information from the preceding cell in the form of chemicals called neurotransmitters that initiate an electrical impulse.

This electrical impulse ('action potential') travels down the axon towards the axon terminal. Within the axon terminal are sacs, called 'vesicles', that are filled with the neurotransmitter that the cell is specialised to produce. The arrival of the action potential at the axon terminal causes the vesicles to move towards the edge ('membrane') of the axon terminal. There it fuses with the membrane and releases the neurotransmitter into the space between the axon terminal of the first cell and the dendrite of the next one. This space is referred to as the 'synaptic cleft' or 'synapse'.

The neurotransmitter molecules drift across the synapse and connect with receptors on the dendrites of the post-synaptic neurone. When the neurotransmitter binds with the receptor it triggers an action potential in the axon of the post-synaptic neurone and the process continues.

The axon can be thought of as a wire or cable, sending an electrical signal from one end to the other. Similarly, the axon is insulated (like the plastic around your household wires). The insulation around an axon is a fat-based substance called 'myelin', which helps to increase the speed at which the action potential travels down the axon.

Glia

Glia are brain cells that do not send messages but help to protect and

support the function of neurones. Some types of glia are astrocytes, oligodendrocytes and microglia. I'll just highlight a couple of their functions as they will be relevant later on.

Astrocytes One of the main functions of astrocytes is maintaining the physical shape of the brain, but they are also important for the development and survival of neurones and can increase the strength and activity of synapses, as well as their overall development. Astrocytes feed neurones by extracting nutrients from the blood and passing them to neurones. They are also able to produce glucose, the preferred form of energy for nerve cells.

Oligodendrocytes This type of glial cell produces two proteins called brain-derived neurotrophic factor (BDNF) and insulin-like growth factor-1 (IGF-1). These proteins promote the growth of new neurones and connections (synapses) and support the survival of the ones we already have. This is hugely important because, as you will come to see, protecting the brain cells we already have is the best hope we have of securing long-term brain health.

In the brain and spinal cord oligodendrocytes produce the myelin that wraps around the axon.

Microglia Microglia make up about 15 per cent of the brain and play an important role in the brain's immune response. Microglia have long branches that stretch out and monitor the conditions around nearby nerve cells. When they notice a problem one of the things they do is engulf or 'eat' harmful agents within the brain, such as bacteria from an infection (a process called 'phagocytosis').

They are also able to fight off unwanted pathogens by releasing powerful toxic chemicals. However, if this process goes unchecked these chemicals can actually harm neurones. We'll talk about the circumstances under which this happens in Chapter 5.

When they are activated by the presence of bacteria, a virus or a brain injury, the microglia multiply and release compounds called 'cytokines'.

Cytokines are the group name for a number of different proteins that play a crucial role in our immune system's response to illness or injury. When the threat is controlled, the microglia signal for the start of repair processes to fix the damage that has occurred.

The blood–brain barrier

The membranes around most body cells and the lining of blood vessels are partially permeable, which means that they allow water and some other molecules through. This allows the water you drink to pass through the blood vessels and reach the dehydrated cells in your fingertips, for example. These partially permeable membranes are like the friendly doormen at a nightclub; they'll check your ID and let you through.

Your brain, however, is incredibly selective about what it allows in. Instead of a friendly doorman, the tight junctions of the blood–brain barrier (BBB) are more like a fingerprint scanner at an exclusive private members' club. Only the elite few can gain entry.1 This exclusivity means that even cells that form part of the body's immune system can't get through. This is one of the reasons why the brain has developed its own immune defence system in the form of microglia. This selectiveness is essential because the brain is so important and vulnerable to damage that you do not want to risk exposing it to anything that might cause harm.

If something happens in the body that impairs the function of the BBB there may be many negative consequences:

Interference with the action potential of neurones. Depending on what part of the brain is affected this could contribute to impairments in thinking or movement.

Immune cells from the body's immune system can get into the brain. Since this is not where they belong this can create a lot of confusion. Either they can mistakenly attack healthy brain tissue, or the brain's own immune cells will attack them. Sometimes both. If this happens the brain may end up in a state of 'neuroinflammation', which is associated with a number of brain diseases and mental health disorders.

Neural networks

Groups of cells that work together for a particular process form a 'neural

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Chapter 8: To Fast or Not to Fast

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