Richard Wiseman

NIGHT SCHOOL

Wake Up to the Power of Sleep

MACMILLAN

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Introduction

WAKING UP

Where we come face-to-face with the devil,
discover the pressing need for Night School,
and set off into the darkness.

Something deeply strange happens every day of your life. You close your eyes, become oblivious to your surroundings, and repeatedly journey into a fantastical world. In this imaginary realm you might fly around, spend quality time with your favourite celebrity, defend the earth against a zombie apocalypse, or watch in horror as all your teeth fall out. Eventually, you regain consciousness, open your eyes, and carry on with your life as if nothing strange has happened. Perhaps most remarkable of all, this is not a brief experience. On average, you sleep for a third of each day, and a quarter of this time is spent dreaming.

Unfortunately, few people have any idea what happens during this part of their lives. *Night School* takes you on an in-depth tour into the science of sleep and dreaming, and presents practical techniques that you can use to get the most out of the night. During our time together we will discover what happens to your brain and body every night of your life, uncover the mysteries of the human sleep cycle, learn how to overcome nightmares, discover how to enjoy a great night's sleep, and find out how your dreams have the power to change your life.

I first became interested in the science of sleep a few years ago after I started to share my bedroom with the devil. Our clandestine meetings happened about once a week and always took the

same form. Shortly after falling asleep, I would wake up in a cold sweat, stare across my room, and see Satan standing in front of my wardrobe. Sometimes he would start to move towards me, and other times he seemed content to keep his distance. Either way, it was a terrifying experience. After about a year of these strange happenings I was invited to take part in a public event on ways in which psychology can improve your life, and was delighted to discover that I would be sharing the stage with a highly regarded sleep expert, Dr Chris Idzikowski.

Chris is an amiable fellow who has had a long and colourful career investigating many aspects of sleep, including the best way to overcome jet lag and whether it's possible to carry out a murder when you are asleep. After the panel had finished, Chris and I went for a drink and I took the opportunity to tell him about my regular sightings of Satan by my wardrobe. After going through all the gory details I asked Chris whether I was having some kind of recurring nightmare. He asked a few simple questions. Did I ever scream out? How quickly did I get back to sleep? Did I suddenly sit up in bed? Chris then calmly explained that I was not experiencing a nightmare, but rather a very different phenomenon known as a 'night terror'. To the uninformed, these two experiences appear very similar. However, years of research into sleep and dreaming has revealed that they have very little in common. I walked away with a few top tips on avoiding night terrors (more about these later in the book), and I am delighted to report that I haven't seen Satan since.

Intrigued by the ease with which Chris exorcized my devilish tendencies, I started to explore the science of sleep and dreaming. Over time, my casual interest developed into a deep fascination, and I tracked down increasingly obscure academic papers in dusty journals and met up with cutting-edge sleep researchers.

I discovered that for the past sixty years or so, a small group of maverick investigators have devoted their lives to the night, often working long and unsociable hours to uncover the secrets of the sleeping mind. Never ones to shy away from controversy, these nocturnal scientists have carried out several strange experiments, spending months living in underground caves, staging secret studies with a legendary rock band, monitoring people as they attempted to set world records for staying awake, and bombarding entire villages with night-time messages. Inspired by this work, I carried out my own research, staging a mass participation experiment to discover whether people can take control of their dreams, assembling the world's largest dream bank (which now contains millions of reports), and creating the ultimate sleep environment.

For centuries, most people adopted a 'nothing to see, move on' approach to the night. They assumed that your sleeping mind is dormant, and that your time in bed has no real impact on your life. More recently, the scientific study of sleep and dreaming revealed that nothing could be further from the truth. In fact, each night you embark on an extraordinary journey that influences how you think, feel, and behave when you are awake. After years of tireless research, sleep scientists managed to map every stage of this fascinating journey, including which parts of your brain jump into action when you fall asleep, how to banish nightmares, and what your dreams really say about your psyche.

The work has, however, also uncovered the dark side of the night. Increased workloads, twenty-four-hour media, and permanent Internet access has combined to create a world that now never sleeps. The statistics are staggering, with surveys revealing that a third of both British and American adults do not get the sleep that they need, and that the vast majority of children

arrive at school overtired. In 2010, British doctors issued more than fifteen million prescriptions for sleeping pills, and around one in ten adults now regularly take some form of sleep-related medication.

This epidemic of sleep deprivation is having a catastrophic impact on our lives. Around a quarter of drivers admit to falling asleep at the wheel, and fatigue is responsible for thousands of fatal road accidents each year. Poor sleeping habits also reduce productivity, prevent learning, disrupt relationships, cramp creative thinking, and sap self-control. As we will discover later in this book, some of the latest research suggests that poor sleep in adults is also associated with depression and obesity, and may cause children to exhibit many of the symptoms associated with attention deficit hyperactivity disorder (ADHD). Worst of all, even a small lack of sleep can have a detrimental effect on health, and is linked to an increased risk of heart disease, diabetes, high blood pressure, and an early death.

It doesn't have to be like this. As I continued my exploration into sleep science, I realized that much of the research could be used to create techniques to help those struggling with the night. Also, in the same way that these techniques can help move people from being a poor to good sleeper, so they can also help others go from good to great. During my research I uncovered the existence of super-sleepers. These people are able to fall asleep whenever they want, wake up feeling refreshed, and have lots of sweet dreams. Compared to most, they are significantly more likely to be happy, healthy, and wealthy. I believe that almost everyone can improve their sleep and make the most of their dreams and, in doing so, become a super-sleeper.

For years the self-development movement has focused on improving people's waking lives. *Night School* reveals how every-

one can make the most of the remaining third of their day. It's time to reclaim the night, to change your life while you are sound asleep, and to wake up to the new science of sleep and dreaming. Welcome to Night School.

ASSIGNMENT

It's all in the timing

Throughout *Night School* you will be invited to carry out a series of specially designed questionnaires and exercises. Some are designed to be fun, and others have a more serious side.

This first one will take just a few moments, and involves completing the following questionnaire.[1] Don't spend too long thinking about each question, but instead just circle the response that instantly feels right. Oh, and please ignore the numbers under each of the possible answers (shown in italics); we will come back to those later. OK, away you go.

1) If you were free to plan your evening, and had no commitments the next day, what time would you choose to go to bed?

Before 21.00	21.00–22.30	22.30–00.00	00.00–01.30	After 1.30
1	*2*	*3*	*4*	*5*

2) If you were free to plan your day, what time would choose to get up?

Before 06.30	06.30–08.00	08.00–09.30	09.300–11.00	After 11.00
1	*2*	*3*	*4*	*5*

3) In general, do you find it easy to get up in the morning?

Definitely yes	Yes	Uncertain	No	Definitely no
1	*2*	*3*	*4*	*5*

4) Imagine that you have to do two hours of physically hard work. If you were entirely free to plan your day, in which of the following periods would you choose to do the work?

08.00–11.00	11.00–13.00	13.00–15.00	15.00–17.00	17.00 – 19.00
1	*2*	*3*	*4*	*5*

Lesson 1

INTO THE NIGHT

Where we find out what happens to your brain and body every night of your life, discover how to overcome jet lag, and learn the 'ninety-minute rule'.

Welcome to your first day at Night School. In this lesson we will explore two ideas that underpin the whole of sleep science and, in doing so, find out what happens to your brain and body every night of your life. We begin by examining the electricity coursing through your brain right now, then we'll meet an eccentric German professor who spent his life attempting to prove the existence of telepathy, and finally we'll spend the night in a modern-day sleep laboratory.

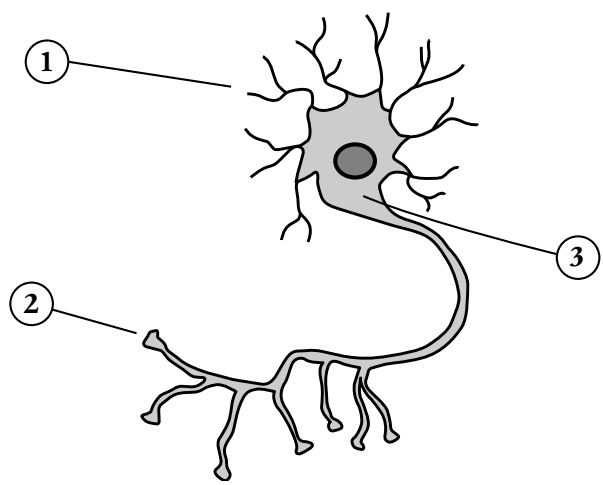
The personification of static

I would like to start by telling you something that has been playing on my mind for quite some time. You are amazing. There, I've said it and there's no going back. However, before you start to feel overly smug, there's something else that I need to say. I think your closest friend is amazing too. In fact, I think that everyone you know is remarkable (except for John in Accounts, who is actually quite annoying). And why are you all so jaw-droppingly wonderful? Because each of you owns one of the most wondrous, and complex, objects in the universe. This object has cured disease, put men on the moon, and created breathtaking works of art.

It allows you to see the world and listen to music, to make momentous decisions and move around, to laugh and to love. This remarkable object is sitting between your ears at the moment, quietly whirring away and allowing you to read this sentence. I am, of course, referring to your brain. (If you hadn't figured that out by now, I retract my initial compliment.)

Although everyone has a brain, most people are unaware that their mind runs on electricity.

If you were to slice off the top of someone's skull you would come face-to-face with what appears to be a large lump of pink jelly. Study any section of this strange substance under a high-powered microscope and you will find that it's made up of lots of tiny cells called 'neurons' (see the diagram of a neuron below). Each neuron consists of three main sections – (1) 'dendrites', finger-like fibres that receive signals from other cells; (2), 'axons', which pass signals to other cells; and (3) a 'cell body', which controls everything. Together, these deceptively simple cells are responsible for every thought that has crossed your mind and every emotion that you have experienced.



Neurons are little electronic messaging systems. When the dendrites receive a signal from a neighbouring neuron, the cell body springs into action and sends a tiny electronic pulse down its axon and on to the surrounding cells. These electronic messages are zipping around your head at this very moment, sometimes at speeds in excess of 200 miles per hour. Neuroscientists now believe that there are about 20 billion neurons in the average brain, and more than 160 trillion connections between them. Although any one neuron only creates a tiny amount of electricity, their combined output is considerable, with the average brain generating enough energy to power a 20-watt light bulb.

Around the turn of the last century, scientists were aware that the brain ran on electricity, but couldn't figure out a way of measuring the tiny signals produced by groups of neurons. Enter the most curious of men, Dr Hans Berger.[1]

Born in Germany in 1873, Berger's life changed forever when he had a close encounter with a cannon. Berger had enlisted for the cavalry service in his twenties. During training, he was thrown from his not-so-trusty steed and landed in the path of a horse-drawn cannon. The driver of the artillery battery carried out a textbook emergency stop which left Berger badly shaken but unhurt. At the precise moment of the accident, Berger's sister had had a strange feeling that her brother was in danger and sent a telegram asking if he was OK. This was the only telegram that Berger had ever received from his family, and he struggled to write off the experience as a coincidence. Instead, Berger became convinced that the spooky event was proof of telepathy, and devoted his life to discovering how thoughts can travel from one mind to another.

Working alone, Berger was desperate to develop what he referred to as a 'brain mirror' – a system of sensors that could be

placed on the scalp and used to measure the tiny amounts of electricity being generated by the neurons inside the skull. Berger's experiments were as time-consuming as they were frustrating, but he locked himself away in his laboratory and persevered in the face of failure (Diary entry, 1910: 'Eight years! Trying always, time and again.'). The German professor grew increasingly distant from his colleagues and came to be seen as a deranged madman. To devote as much time to his research as possible, Berger ensured that his life was highly automated and predictable, with one of his colleagues later noting Berger 'never overlooked a deviation from established routine . . . His days resembled one another like two drops of water. Year after year he delivered the same lectures. He was the personification of static.'

After two decades of disappointment, Berger made a series of technological breakthroughs that hinted at success (Diary entry, 1924: 'Is it possible that I might fulfill the plan I have cherished for over twenty years?'). After spending several more years refining his invention, Berger finally announced that he was able to reliably record brainwaves, and demonstrated the world's first fully functioning electroencephalogram (or 'EEG machine' for short).

Unfortunately, the academic community adopted a somewhat closed-minded response to Berger's invention. Convinced that it was impossible to detect such tiny amounts of electrical activity from sensors placed on the scalp, many of Berger's colleagues assumed that his findings were due to either error or fraud. After retiring from academia in 1938, Berger's health quickly deteriorated and he became deeply depressed. The maverick measurer of minds eventually took his own life in 1941, hanging himself in hospital.

Berger didn't ever prove the existence of telepathy. Instead, he left a far more wondrous and tangible legacy. Academics across

the world eventually realized that he had made a genuine breakthrough, and began to take a closer look at his remarkable invention. One of the first in the queue was a Wall Street tycoon and eccentric researcher named Alfred Lee Loomis.

The palace of science

Born in 1887, Loomis was both an amazingly successful investment banker and the last of the great amateur scientists.[2] As a child, Loomis was fascinated by puzzles, chess, and conjuring. As a young man he developed a passion for science, and eventually struck up a close working relationship with a well-known experimental physicist from Johns Hopkins University named Robert Wood. It was an odd but productive collaboration. At one point, for example, Wood built a large 'spectrograph' (a device designed to disperse radiation into a spectrum) in his barn, but discovered that the instrument's forty-foot tube was frequently ineffective because it became filled with spider webs. Wood and Loomis eventually came up with a strange but highly effective solution to the problem. Whenever the spectrograph became blocked, the intrepid duo would drop a cat in one end of the tube and place some food at the other end. As the cat made its way towards the food, its fur acted like a huge duster and removed the cobwebs.[3]

Loomis enjoyed his time in the barn and eventually decided to build his own private research institute. In the 1920s, he bought a large mansion in New York State, and set about creating his 'palace of science'. Over the next decade, he fitted out his mansion with cutting-edge technology, and played host to some of the world's best-known scientists, including Niels Bohr,

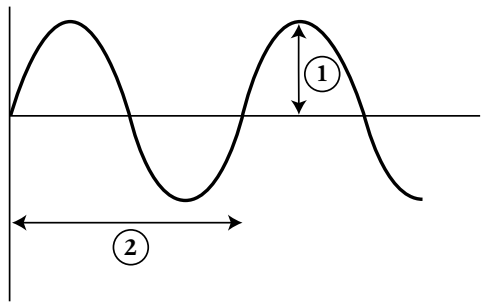
Guglielmo Marconi, and Albert Einstein. Loomis made several important scientific and technological discoveries, including playing a key role in the development of radar, inventing a new way of meas-uring the muzzle velocities of guns, and helping to create ground-controlled approach systems for aircraft.

In the mid-1930s, Loomis heard about Hans Berger's remarkable invention and wondered whether it could be used to investigate sleep. He constructed his own EEG machine, and invited overnight visitors to his palace of science to have their brains monitored. Within a year, Loomis discovered that people's brains are not dormant when they are asleep but instead produce a small number of distinct types of waves. Additional work revealed that these waves occur in a highly predictable pattern throughout the night (we will discover more about this pattern later in this lesson). Although identifying these different stages of sleep was a remarkable step forwards, one final mystery remained. This last piece of the puzzle only fell into place twenty years later, and was the result of one of the most important experiments conducted in the twentieth century.

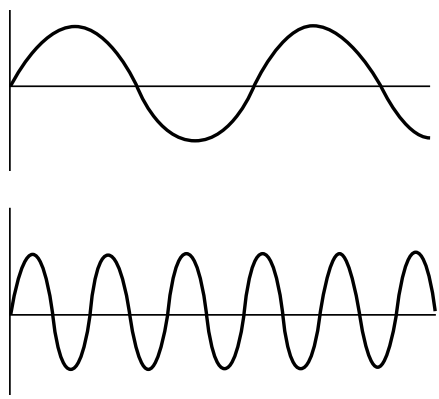
What's in a wave?

The brainwaves that are detected by EEG machines have two main features: amplitude and frequency. Both of these features are illustrated in the diagram opposite.

The amplitude (1) is simply the maximum amount of energy the wave has, and the frequency (2) is the number of times that the wave repeats each second. The frequency is usually measured in units referred to as hertz, or 'Hz' for



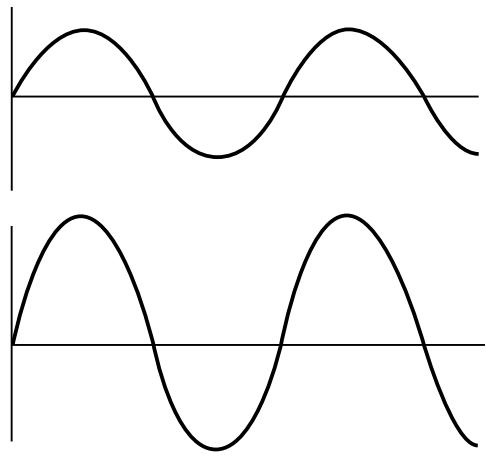
short. To understand the difference between amplitude and frequency, it's helpful to sing a little song. Please sing 'Laaaa' in a deep voice. You have just produced a low-frequency note that would look something like the top line in the following diagram.



Now please sing 'Laaaa' again, but this time in a much higher pitch. If you were to plot the frequency of your voice now, you would get something that resembles the lower line in the diagram above.

Finally, try producing two more 'Laaaaa's, ensuring that they are the same pitch, but that one is much louder than the other. This time you are changing the amplitude of the wave, rather than the frequency, and so the quieter note would look

like the top line in the diagram below, while the louder one would look like the bottom line.



It's the same with brainwaves. Each brainwave can be classified according to the degree to which it is 'loud' or 'quiet', and 'low' or 'high'. In principle, this could result in millions of different kinds of waves. However, in practice, your sleeping and dreaming brain only produces a handful of different waves. For instance, when you are wide awake your brain creates 'beta waves'. There are about twelve to thirty of these waves produced each second, and so they show up on an EEG graph as rapidly changing squiggles.

When you relax, the frequency of these waves suddenly slows down until there are only about eight waves each second. The resulting waveform is referred to as an 'alpha wave' or 'Berger Wave' (named in honour of Hans Berger). During sleep, these waves become slower still, and we will take a closer look at each of the waveforms associated with the different stages of sleep later.

How to draw blood from a turnip

In 1951, Eugene Aserinsky was having a tough time of it.[4] Aged thirty, he was struggling to provide for his wife and son, with the entire family living in a small Chicago apartment heated by a single kerosene stove. Aserinsky had had an odd career path. After excelling at school he had skipped from college to college studying everything from Spanish to dentistry, failing to focus. He left education without a degree and found work as a high explosives handler in the army. After spending time taking his life in his hands, he decided to return to college. At the time, the University of Chicago had a reputation for accepting students with unusual backgrounds, and the unconventional Aserinsky was eventually enrolled in their physiology graduate programme.

When he arrived, he was less than delighted to discover that the only available academic advisor was an infamous and eccentric professor named Nathaniel Kleitman. The Russian-born Kleitman had dedicated his life to researching the science of sleep. In 1939 he had reviewed more than 1,000 scientific papers on the topic and written the then-bible of sleep research, *Sleep and Wakefulness as Alternating Phases in the Cycle of Existence*. Kleitman had also gained a considerable reputation for acting as his own guinea pig in the most challenging of conditions. In one series of studies, for instance, he had investigated how sunlight influenced sleep by spending a month in a large rock chamber deep within Kentucky's Mammoth Cave, by living on a submarine, and by exposing himself to almost continuous sunlight above the Arctic Circle. These endurance studies appear to have caused little long-term harm, with Kleitman dying at the ripe old age of 104 in 1999.

Kleitman met with Aserinsky and suggested that he study the

way in which babies blink when they fall asleep. Aserinsky found his endless observation of babies as 'exciting as warm milk' and, after spending months trying to 'draw blood from this research turnip', decided to call it a day. He switched his attention to brain activity and eye movements in sleeping adults. At the time most mainstream scientists thought that these eye movements were meaningless events that took place at random times throughout the night. Never one to follow the crowd, Aserinsky dragged an old EEG machine out from the departmental basement to his office and set to work.

He decided to start off by simultaneously measuring people's brain activity and eye movements throughout an entire night. This ambitious goal pushed the existing technology to its limit, as it required his dated EEG machine to operate smoothly for several hours. Aserinsky decided to carry out an initial test of the equipment by monitoring his son.

So it was that, on a cold night in December 1951, eight-year-old Armond Aserinsky found himself lying in a laboratory bed with his head covered in sensors. Some of the sensors measured his brain activity and others monitored the muscles around his eyes. All of this information was fed back to the EEG machine in a nearby room, where Aserinsky Sr sat watching several pens trace out the activity on a long roll of graph paper. This was no small-scale enterprise, with a single night of monitoring resulting in over half a mile of graph paper. As the night went on, Aserinsky Sr struggled to keep the out-of-date EEG machine up and running, unaware that he was just about to secure his place in history.

A few hours into the session Aserinsky Sr was surprised to see the pens suddenly start to scribble away, indicating that Armond's brain and eye muscles were highly active. Aserinsky Sr assumed

that his son had woken up, and so went along to the corridor to see what had happened. When Aserinsky Sr opened the laboratory door he was amazed to discover that his son was sound asleep. Even more remarkably, this rather curious pattern was not a one-off affair, with Aserinsky Sr observing similar bursts of brain activity and eye movement throughout the night.

The next morning Aserinsky Sr tried to discover the cause of this mysterious activity. At first Aserinsky assumed that the old EEG machine was broken, and started the laborious task of checking the endless leads, dials, and valves. When he failed to find a problem he shared his results with Kleitman. Initially sceptical and perhaps suspecting fraud, Kleitman asked his student to re-run the procedure but this time using Kleitman's daughter as the participant. When the same pattern of data emerged, Aserinsky became more confident that he was on to something big, and labelled the curious phenomenon 'rapid eye movement' or 'REM' for short (Aserinsky originally thought about calling it 'jerky eye movement' but was worried about the negative connotations of the word 'jerk'). Intrigued, Aserinsky and Kleitman decided to find out what was going through people's sleeping minds when the EEG produced these strange nocturnal patterns.

Aserinsky arranged for a group of twenty volunteers to come to the laboratory. He woke them up whenever they entered REM state and interviewed them. Describing his findings in a now-classic paper ('Regularly Occurring Periods of Eye Motility, and Concomitant Phenomena, During Sleep'[5]), Aserinsky noted that the vast majority of them reported a dream.

This paper had an enormous impact, with one leading scientist announcing that Aserinsky had discovered a new continent in the brain. For years the only dream reports available to researchers had come from people trying to recall their dreams each morning.

These reports were often patchy, incomplete, and unreliable. The discovery of REM changed the face of sleep science overnight and provided researchers with a direct route into the dreaming mind. As a result, scientists across the world started to investigate sleep and dreaming. Strangely, Aserinsky was not one of them. Ever the incurably curious polymath, Aserinsky switched to examining the effects of electrical currents on salmon, passing away in 1998 when his car swerved off the road and collided with a tree. Ironically, it is thought that he had probably fallen asleep at the wheel.

Aserinsky's remarkable discovery changed the world, and provided a pathway into the hitherto hidden world of dreaming. It was also the final piece of the sleep-science jigsaw and allowed researchers to map out exactly what happens to people every night of their life. To explore this map, it's time to visit a modern-day sleep centre.

Five amazing facts about dreaming

The discovery of REM has allowed sleep scientists to explore the mysteries of dreaming. Here are five of their strangest findings.

Dreaming in colour

The degree to which people experience colour in their dreams may depend on their childhood experience. Eva Murzyn, from the University of Dundee, asked people in their mid-fifties to rate both the amount of colour in their dreams, and how much black-and-white television they watched during their childhood. 25 per cent of those who

only saw monochrome television when they were young dreamt in black and white, compared to just 7 per cent of those who had access to colour television.[6]

Up all night

Researchers have carefully measured the extent of male erections during dreaming and then compared this to the content of the dreams.[7] The findings show that erections happen during even the most mundane of dreams, and are not necessarily the sign of an erotic adventure.

Dreams of the blind

Research into the dreams of blind people has revealed that those who lose their sight before the age of seven experience dreams that contain almost no visual imagery, whereas those who become blind after they are seven years old have the same type of visually oriented dreams as sighted people. Also, those who are blind from birth report dreams that frequently involve vivid sensations of sounds, taste, smell, and touch.[8]

The importance of impotence

Nocturnal erections can help medics to determine the causes of impotence. If a patient does not get an erection during their sleep, then their impotence may be due to a physical problem that is best treated with drugs or surgery. However, if the patient has no problem 'staying up' all night then the problem is likely to be more in the mind.

You are blind when you dream

David Foulkes, from the University of Chicago, invited volunteers to his sleep laboratory, taped open their eyelids, and asked them to fall asleep.[9] When the volunteers started to dream, Foulkes tiptoed into the room and placed various

objects in front of their eyes, including an aluminium coffee pot and a card bearing the somewhat ironic message 'Do Not Disturb'. The volunteers were then woken up, asked to report their dream, and quizzed about what they thought had been happening right in front of their eyes. The volunteers saw nothing, and the objects didn't crop up in their dreams, suggesting that you become blind when you dream.

A touch of the Bram Stokers

Spend time in any psychology department and you will soon learn to spot the different kinds of researchers at work. The social psychologists are the ones who are unable to maintain eye contact, the memory researchers have forgotten where their offices are, and the persuasion experts will be arguing how best to split a bar tab. No matter how long you spend there, however, you are unlikely to spot that rarest of researchers, the sleep scientist.

This unusual breed enjoys a nocturnal and solitary existence. They arrive at their offices just as everyone else is heading home, climb into their beds when the rest of the world is waking, and often only meet one other person at work (and, all being well, that person will be asleep).

Stevie Williams is one of these researchers. Stevie is the head technician at one of the UK's best-known sleep clinics – the Edinburgh Sleep Centre. I first met Stevie a few years ago when we were both involved in a project examining whether psychics could dream about the future (they couldn't). Stevie is in his mid-thirties and, like most sleep researchers, has what I refer to as 'a touch of the Bram Stokers'. Although healthy looking, his skin

has a thin, pallid quality, which I suspect is a direct result of his vampire-like existence.

Stevie had heard about my interest in sleep science, and kindly invited me to spend a night being monitored at his sleep clinic. Entering the clinic's sleep room is like being on the set of a stage play. On the face of it, everything looks like a normal bedroom or hotel room. Deep down, however, you have a strange feeling that all is not quite as it seems. Sneak a peek behind the bed and you will discover an endless array of sensors, tubes of gel, rubber caps, and miles of cabling. To the twenty-first-century sleep researcher this is exactly what you need to follow people as they journey into the night.

After I had changed into my pyjamas, Stevie glued about twenty small sensors in place on my scalp with a special gel, carefully connected a long wire to each sensor, and then gathered the wires together to form a strange-looking ponytail. The set-up looked bizarre but actually felt surprisingly comfortable. Stevie asked me to climb under the duvet, and then carefully placed the ponytail over the side of the bed. Finally, Stevie checked the positioning of the infrared camera that would record my every toss and turn throughout the night, and left the room.

The sleep centre's bed was remarkably comfortable, and after only a few seconds I found myself drifting off. The next moment Stevie was back by my bed gently waking me up. I assumed that it was the middle of the night and that something had gone wrong with the equipment. In fact, it was 7 a.m., and I had just enjoyed the best night's sleep that I had had for years. Stevie then asked me to change back into my civvies and meet him in his office.

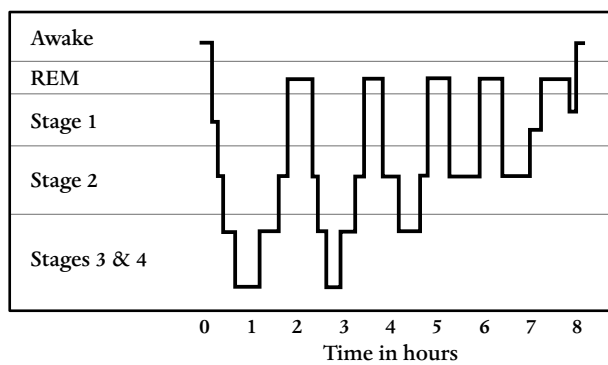
I felt as if my mind had been in shut down-mode for the previous eight hours. No dreams. No activity. Zilch. Yet when Stevie showed me the EEG graphs from the night it was obvious that

nothing could have been further from the truth. As he reviewed my data, it became obvious that my EEG trace was almost identical to the one produced by Aserinsky and Kleitman all those years ago. Modern-day sleep researchers refer to this pattern as the 'sleep cycle'. Over breakfast, Stevie kindly took me through each stage of the process.

It's just a stage he's going through

As we have seen, when you are wide awake your brain produces an erratic-looking EEG trace that contains between twelve and thirty waves each second. Soon after you climb into bed, the frequency of these rapidly changing squiggles slows down until there are only about eight to twelve waves each second. This type of trace is often associated with relaxation and meditation, and is known in the trade as 'alpha activity'.

After a few more minutes, your breathing will slow down, your eyes will roll from side to side, and the frequency of your brainwaves will become even lower. You are now entering **Stage 1** of sleep (see graph). You only enter this stage a handful of times



during the night, and each of these visits is very brief. During this stage your brain will be producing between three and seven waves every second or, to give them their technical name, 'theta' waves. If you are woken up during this stage, you are likely to feel like you weren't really asleep.

During your first encounter with Stage 1 sleep you might produce the odd twitch or two, and see illusory pinpricks of bright light or hear non-existent loud bangs (known as 'hypnagogic hallucinations'). Your muscles will also start to relax, and you are likely to experience a general 'loosening' of thought. Artists and writers have attempted to use this experience as a source of inspiration. For instance, surrealist Salvador Dali would lie down and place a glass on the floor. He would then put one end of a spoon on the edge of the glass and hold the other end between his fingers. As he drifted into Stage 1 of sleep, Dali's fingers would naturally relax and release the spoon. The sound of the spoon crashing into the glass would then wake him up, and Dali would sketch the odd images that were drifting through his mind.

This stage is also associated with a rather strange phenomenon known as the 'hypnagogic myoclonic twitch', which often starts with the sensation that you are falling before you suddenly find that your entire body has jolted itself awake. Around about 70 per cent of people experience these twitches, and they seem to be associated with exhaustion or sleeping in an uncomfortable position. Sleep scientists are not quite sure what causes the twitches, with some researchers arguing that as you fall asleep your muscles begin to relax, and the brain somehow misinterprets this as evidence that you are falling. Some evolutionary psychologists speculate that it might have developed from a time when people fell asleep in trees, and was designed to stop them falling out when they slept like a log.

You only experience Stage 1 of sleep for between two and five minutes. As you drift into the next stage of sleep, your heart rate slows down and your body temperature lowers. The 'theta waves' are joined by brief bursts of electrical activity known as 'spindles' and 'k complexes'. These appear to play a vital role in blocking out any external stimuli (such as a noise outside on the street) and internal stimuli (such as feeling a tad peckish) that might otherwise wake you up. You have now reached **Stage 2** of sleep. During this time almost all of your muscles, including those in your throat, start to relax, which can cause you to mumble or snore. Your brain is also taking a well-earned rest too, with a lowering of activity in areas associated with thought, reasoning, language, and problem solving. As we will discover in a later lesson, this stage is vital to learning physical activity, such as mastering a music instrument, new dance, or sporting skill.

Researchers often group the first two stages of sleep together, and refer to them as 'light sleep'.

After about twenty minutes in Stage 2 of sleep, your brain and body becomes especially relaxed, and you enter **Stage 3** and **Stage 4**. At this point your brain activity is at a minimum, resulting in very slow-moving 'delta waves' (only about one or two waves each second). Together, these stages are referred to as 'deep sleep' or 'slow-wave sleep'. During this time you will be almost completely cut off from the outside world (unless you happen to smell burning, someone says your name, or you hear a very loud noise). It's extremely difficult to wake up someone when they are in deep sleep, and if you do manage it they are likely to feel groggy and disoriented for several minutes.

Deep sleep stages are vital to your psychological and physical well-being because they are associated with the production of growth hormones that help repair damaged tissue. Without these

stages you would wake up feeling tired and grumpy. These stages are also important for consolidating important information from the day, and are also associated with sleepwalking, sleep talking, and night terrors. When Stevie looked at my EEG trace he could see evidence of my tendency for night terrors. During deep sleep it's unusual for people to move around, but the recording from the infrared camera showed that I often moved my hands and arms.

Sleep scientists classify the first four stages of sleep as 'Non-REM' (or 'NREM') because they don't involve the type of rapid eye movements associated with dreaming. But does this mean that there is nothing going through your head during this time? If you are woken up from NREM sleep you are highly likely to report some kind of random, fragmented thought. This might take the form of a single word, or concept, and lack the strong sense of storyline that we commonly associate with dreaming.

After around thirty minutes in deep sleep, something very strange happens. Your brain and body move rapidly back through the different stages until you reach Stage 2. Then, instead of being relaxed, your heart starts to race, your breathing becomes shallow, and your eyes dart from side to side. Now you are experiencing rapid eye movement, or **REM**. During this time your brainstem completely blocks any bodily movement to prevent you acting out your dreams. If you were to be woken up now you would almost certainly describe a vivid dream. It is also quite likely that your sexual organs will be going into overdrive, with men gaining an erection and women showing increased blood flow to the vagina. Most people are in REM state, on and off, for about a quarter of the night, and this is sometimes referred to as 'paradoxical sleep' because the brain is almost as active as it is when you are awake. As we will find out later on in *Night School*, this stage plays a vital role in enhancing your memory, helping

you deal with traumatic events, and seeing problems from a fresh perspective.

Having completed your first dream of the evening you move back down through the stages, and this NREM–REM–NREM sequence repeats itself again and again throughout the night. Each cycle takes around ninety minutes, resulting in an average of five dreams per night.

After each dream you might experience a very brief 'micro-awakening', wherein you are actually fully awake but for such a short time that you will not remember it in the morning. In a typical night, about 50 per cent of the time is spent in light sleep, 20 per cent in deep sleep, 25 per cent in REM, and 5 per cent having brief awakenings. The start of the night tends to be dominated by deep sleep, with relatively short dreams. However, as the night wears on the dreams become progressively longer and the periods of deep sleep correspondingly shorter. Indeed, in the second half of the night there is almost no deep sleep, and the REM can last up to forty minutes at a time.

The ninety-minute rule

Speak to sleep researchers and you will soon discover that most of them use a little-known trick to help them feel refreshed the next day. You will feel most refreshed when you awake at the end of a ninety-minute sleep cycle because you will be closest to your normal waking state. To maximize the chances of this happening, figure out when you want to wake up, then count back in ninety-minute blocks to find a time near to when you want to go to sleep.

Let's imagine that you want to wake at 8 a.m., and wish to go to sleep around midnight. Chunking back in ninety-minute segments from 8 a.m. would look like this:

8 a.m. → 6.30 → 5.00 → 3.30 → 2.00 → 12.30 → 11 p.m.

In this example, you should fall asleep around either 11 p.m. or 12.30 a.m. in order to feel especially refreshed in the morning.

After breakfast I thanked Stevie for talking me through the night, said goodbye, and walked out into the morning sun ready to face the day. Behind me, Stevie locked up the sleep laboratory and headed for his bed.

The sleep cycle plays a vital role in understanding what happens to your brain and body every night of your life. It is, however, only part of the picture. To fully appreciate the fundamental nature of sleep it's also important to get your head around a second key idea. It's time to discover what really makes you tick, and meet a man who changed the world by locking some plants in a cupboard.

The clockwork universe

The great eighteenth-century French astronomer Jean-Jacques d'Ortous de Mairan spent much of his career staring up at the sky.[10] In 1729, however, a rather more down-to-earth phenomenon caught de Mairan's attention. For centuries philosophers had observed plants opening their leaves during the daytime and closing them at night, and concluded that this curious behaviour was driven by sunlight. De Mairan wasn't convinced by their

arguments, and decided to conduct a simple study that would put centuries of accepted wisdom to the test.

De Mairan decided to conduct his now-classic experiment with the help of the *Mimosa pudica*, a plant known for its rapid and highly predictable leaf movements. Each morning the *Mimosa pudica* opens and lifts its leaves, and every evening it closes and lowers them. De Mairan reasoned that if the *Mimosa pudica* were influenced by sunlight then it should stop moving when it is placed in total darkness. To find out if this was the case, he took one of the plants and locked it away in a pitch-black cupboard. Throughout the following few days de Mairan carefully lit a candle and peaked inside. Despite having no access to sunlight, the plant's leaves remained perky during the day and flaccid at night. His study had revealed that many of the world's greatest philosophers had made a terrible error, and that sunlight was not responsible for the *Mimosa pudica*'s behaviour.

At the time of his discovery de Mairan was working on several important astronomical projects, including exploring whether the colours of a rainbow were related to musical scales and trying to observe Venus's non-existent moons. As a result, the astronomer wasn't especially interested in publishing his work with the humble *Mimosa pudica*. In fact, the paper might not have seen the light of day, had it not been for his friend and fellow scientist, Jean Marchant. Marchant was convinced that de Mairan had made a major breakthrough, and insisted that the paper was published in the proceedings of the Royal Academy of Paris.[11] The article consisted of just 350 words. Nevertheless, it changed the science of sleep forever.

Over the next 200 years scientists carried out ever more complex versions of de Mairan's study in an attempt to discover the strange force controlling the opening and closing of plants.

After locking away thousands of plants in ever more secure cupboards, they ruled out every possible candidate, including temperature, humidity, and the earth's magnetic field. Eventually the researchers realized that plants were not responding to an outside force at all, but instead possessed a mysterious kind of internal clock that merrily ticked away regardless of what was happening in the world. Like a beautifully crafted timepiece, this internal clock worked on a twenty-four-hour cycle and ensured that the plant's leaves opened during the day and closed at night.

Flushed with success, the scientists then started to search for similar internal clocks hiding away in other forms of life. From the simplest single-celled organisms to the most amazing mammals, time and again they found what they were looking for. It soon seemed as if the whole of the natural world was controlled by clockwork. After decades of hard work the researchers finally reached the last item on their list: Homo sapiens.

Everyone has a natural tendency to wake up each morning and go to sleep every night, and researchers wondered whether this behaviour could also be the result of an internal clock ticking away in their brains and bodies. It was time for an experiment. De Mairan's initial groundbreaking study involved placing plants inside a pitch-black cupboard and then regularly observing their behaviour. Although carrying out the same study with humans might be fun (providing you weren't the ones in the cupboard), it wouldn't rule out other environmental factors that could influence the wake–sleep cycle, such as temperature, sound, and humidity. To stage de Mairan's experiment with humans, researchers needed to find a location that was completely isolated from the outside world and someone who was willing to stay there for a long time. Enter Michel Siffre, French scientist and adventurer extraordinaire.

Going underground

Born in 1939, Michel Siffre developed a passion for caving and science at an early age.[12] After graduating with a degree in speleology (the study of caves) in his early twenties, Siffre was on the hunt for an interesting research project. At the time a team of geologists had just discovered a subterranean glacier deep inside the French–Italian Alps, and Siffre realized that this was the perfect location for a groundbreaking experiment into the possible existence of the human internal clock.

In 1962, the twenty-three-year-old French adventurer descended nearly 400 feet below the earth's surface and lived in the cave for two months. Throughout the ordeal Siffre regularly telephoned his above-ground team to tell them when he had just woken up or was about to fall asleep. The experiment wasn't easy. Enduring below-freezing temperatures and very high humidity, Siffre suffered from hypothermia and frequently had to dodge large chunks of ice that fell around his tent. Yet Siffre's daily diary shows that he only lost the plot on one occasion. Tired, lonely, and clad only in a pair of black silk stockings, he decided to sing loudly while twisting the night away.

Siffre's suffering paid off, and the results revealed that humans do indeed have an internal clock ticking away inside them. In the same way that the plants in de Mairan's experiment regularly opened and closed their leaves despite being deprived of sunlight, Siffre continued to go to bed and wake up roughly every twenty-four hours. Over the next few years other sleep researchers investigated this mysterious internal clock by locking themselves and others in increasingly isolated underground locations. Their results have revealed an extraordinary insight into what really makes you tick.