grey matter

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Every human being on the planet is different. Every individual's view and understanding of the world is absolutely unique, and this uniqueness is determined partly by nature and partly by nurture. Personality, character and behaviour are the results not only of the structure of the physical brain (nature) but also as a consequence of personal collective experience of life as people grow and develop (nurture.) Individual qualities become encoded and fixed in the brain. Because of this, no two people are ever exactly alike – nor will they react in exactly the same way to circumstances. All human beings have their own distinctiveness.

Your brain is the most complex structure in the universe. It controls every single aspect of your being. Your character and personality is embedded in the tissue of your brain and it's your brain that is the very essence of everything you are – it's the control centre of your fundamental nature, your spirit and some would even argue, your soul. It is your brain and the way it functions that makes you one of billions of unique individuals.

Your brain contains your hopes, your dreams, your precious memories and the knowledge of everyone you love and care about. It's the library for all your thoughts and senses – it's the interpreter of smells, tastes and colours. It can make you feel happy about life or it can make you thoroughly miserable. It has the ability to create wonderful imaginations, both subtle and gross and it can generate terrors that can freeze your soul. Most importantly – and most significantly, it makes you aware of who you are, of your thoughts and what they mean.

When it comes down to it, every single thought, feeling and emotion is just a complex series of chemical and electrical reactions taking place in that lump of grey matter between your ears… in fact the brain can be accurately described as an electro-chemical organ. Just by reading the last sentence, you have engaged literally tens of thousands of neurons and created a similar amount of chemical and electrical reactions.

The brain is the terminus of all the nerves in your body. All the senses – sight, sound, smell, hearing, touch – are actually being experienced in your brain and yet paradoxically, it has no sense of feeling itself.

When you're thinking, your brain uses enough energy to power a dim light bulb or light a small Christmas tree, so the picture of Uncle Fester putting a bulb in his mouth and it lighting up it is not so far-fetched after all!

All these thoughts and emotions use a lot of power – your brain uses about twenty percent of all your energy. Surprisingly though, it uses no more energy when you are relaxing or listening to music than it does when you are thinking hard about a problem.

Even if one half of your brain suffers severe injury, the undamaged half can adapt and learn to do all the work on its own. This is why people who have suffered strokes can, after time and with practice, recover their faculties and learn to function normally again.

At the Harvard Medical School, neuroscientist Alvaro Pascual-Leone tried a ground-breaking experiment – an experiment that is of the greatest significance to psychologists and neurologists alike. Two groups of volunteers were recruited to take part in a simple test. The first group was instructed to play a five-finger exercise on the piano while the second group were asked to focus their attention and imagine they were playing the notes themselves.

Using trans-cranial magnetic stimulation, Pascual-Leone was able to see how much of the brain's motor cortex was devoted to the finger movements of the piano players. The experiment confirmed a growing number of discoveries that players who simply played the notes in their head, holding their hands perfectly still, displayed the same increase in the allocation of neurons. This is an important discovery and it goes a long way to proving that mental training – in this case simply using the imagination – really does have the power to 'rewire' the brain.

The technique is now known as Neuroplasticity. With patients who have suffered strokes, it is possible to retrain neighbouring areas of the brain to 'take over' motor skills lost as a result of the initial stroke.

At the University of California at San Diego, the very famous neuroscientist V. S. Ramachandran knows all about this principle. After many years of painstaking research into 'phantom limb syndrome' he concluded that there is an overlap between different areas of the brain that experience feeling from different parts of the body. For instance, stroking a patient's left cheek with a cotton swab the patient reported feeling the sensation on the back of his missing hand! Stroking another spot on the patient's cheek, he said that he could feel the sensation on his missing thumb. The same thing happened when Ramachandran stroked the skin between the nose and upper lip, the patient saying he felt the sensation in his missing index finger. Brushing a spot just below the left nostril, the patient felt his little finger was being tickled.

An average brain weighs about 1.3 kilos and about eighty percent of that is water, necessary for cooling the brain [without water it will overheat] and as a conduit for all the vital chemical and electrical reactions such as the signals that flash between the neurons that create your thoughts, feelings and emotions.

The brain is made up of folds and ridges and valleys. The cortex itself is about three millimetres thick and if it were unfolded it would be the size of a pillowcase. It's neatly folded into this convenient package so that more brain can be accommodated inside your skull, which protects the delicate tissue and helps you get through doors. In this respect, its design is a miracle of engineering – the result of millions of years of evolution, of millions of years of trial and error before God finally got it right.

If we were able to examine a real brain, the first thing you would probably notice is that it smells a bit like Gorgonzola cheese because of all the potassium it contains. It's not nearly as mushy as you might imagine... in fact it's quite hard, with the consistency of a raw cauliflower, something any neurosurgeon or axe murderer will confirm.

Energy for the brain comes from the sugar and oxygen carried to it by the blood stream and it uses about 750 millilitres (about one pint) of blood every minute. All this blood carries a lot of heat which makes the brain the hottest part of your body. When you feel tired, it's because the muscles in your body are tired and not necessarily because your brain is tired, although the brain does need sleep.

There are about one hundred billion neurons in your brain and you could fit about a hundred on a pinhead. Laid end to end they would stretch for about 1,000 kilometres. Amazingly, unborn babies grow new brain cells at the rate of twenty thousand every second, but after the age of about twenty-five, approximately twenty five thousand brain cells will die every day. Smokers lose even more. Drug addicts lose them at a rate which is both alarming and cause for serious concern.

The brain needs the oxygen carried to it by the blood. If the brain is deprived of oxygen for more than a few seconds, it literally switches itself off and this causes fainting. Wrestlers sometimes perform a move known as the ‘sleep hold’ which cuts off the blood supply to their opponent’s brain and literally causes them to black out within a few seconds. This is highly dangerous and should never be attempted by anyone, except wrestlers who are paid large sums of money to take this sort of infantile risk.

There is no connection whatsoever between the relative size of a person’s brain and their intelligence. Weighing in at a massive eight kilos, an elephant’s brain is the largest of all the mammals and yet no elephant has ever written a book or invented anything worth getting excited about. On average, women’s brains are smaller than men’s brains but in reality, this is only because women are generally physically smaller than men. Japanese people’s brains are, in the main, smaller, because Japanese people are physically smaller than Americans, yet the Japanese are some of the smartest and most creative people on the planet whereas Americans, with their larger brains, are amongst the most stupid.

Intelligence is dictated not by the number of brain cells you have but by the number of connections between neurons – and this is in turn decided by the amount of mental stimulation a person receives as they grow up, from birth until about the age of fourteen. Parents should take note of this, especially as it is now accepted that parents who spend time with their children produce brighter offspring. Brighter children usually make better parents themselves and in turn are far more likely to produce even more intelligent children.

During the first twenty-one months of life, 50% of the neurons in the brain die and this is because the circuits in the brain are constantly being rationalised. Any redundant brain cells are simply surplus to requirements and will be discarded. The more external stimuli received by the brain, the harder the brain has to work and the harder the brain works, the more connections are established and the more the brain develops. The golden rule when it comes to brain cells is – use them or lose them!

There are 150,000 miles of nerves in the average adult human. Nerves carry signals from all the different parts of the body to the brain where they are interpreted before carrying instructions from the brain back to the various parts of the body, including the muscles.

It is only in the last two hundred years that our brains have started to evolve at their fastest rate ever, as they are applied to the more complicated activities than our forbears, such as driving cars, flying aeroplanes, operating computers, solving complex mathematical problems and remaining invisible when employed by government. Comparison of the structure of modern twenty-first century brains with the brains of French soldiers preserved in the permafrost of northern Lithuania following Napoleon’s disastrous retreat from Moscow, reveal the human brain is evolving faster than at any other time in the history of our species.

The areas of the physical brain that deal with special memory – that is those parts allocated to unusual or complex problem solving – are expanding and regrouping at an astonishing yet measurable rate.

You might have heard it said that we only use about 10% of our brains. This is a claim I have repeatedly heard made by, amongst others, Paul McKenna. Unfortunately, this assertion is complete bollocks because every single neuron in our brain has a use and a purpose, even if its particular activity is purely unconscious.

One of the most important things that make the brains of human beings stand out from those of all the other animals on the planet is their exceptional ability to communicate – probably the most important contribution to human survival – even more important than opposable thumbs or the discovery that rubbing two boy scouts together will make fire. After all, we have no sharp teeth or claws with which to defend ourselves, our bodies are not covered with fur to keep us warm (although there was a girl I met in Liverpool) and most of us can't run very fast. All things considered, we are a weak species and we have had to learn to collaborate and work together in groups in order to survive and flourish. Without communication, we would never have been able to invent the steam engine or the aeroplane.

Humans have had to learn to work together not just in order to survive, but to create the complex societies in which we now live. To make it easier to pool our resources and cooperate with each other, modern human brains have developed language. It is language that represents not only our most important survival tool but also our most important evolutionary device. Language helps us to make our intentions known to others and understand others' intentions toward us.

Language makes it possible for us to pass on information. It is this ability to work together and act as a team that has made it possible for our species to achieve the level of civilisation that Adam Smith wrote about in The Wealth of Nations. Adam Smith's theories on the division of labour are fundamental to the economic success of the greater human organism we call civilisation.

Over the three million years of man's evolution, every society has developed along similar lines. Recently discovered primitive societies, from the rainforests of Borneo to the Jungles of South America and Central Africa, have had to develop the same sort of system of sharing of work in order to continue to exist. All these societies have certain functions in common, the most strikingly obvious of which is that the men go out hunting and gathering while the women stay at home, looking after offspring and preparing food and shelter. The similarities between these societies and the old social orders of pre Industrial Revolution Europe is so conspicuous that it cannot possibly be written off as mere chance. Nevertheless, the one common denominator in the development of all cultures has been the ability to use language.

Large parts of the brain are taken up with language and one of these areas is called Broca's area, after Paul Broca, who lived from 1824 to 1880. Broca's most famous patient was a man called Tan. Tan was called Tan because 'Tan' was the only word he could say. Because of this, Tan was probably rather irritating, but after his death, Broca closely examined Tan's brain and found that a particular part of it had been damaged. Broca realised that this must be the area responsible for vocabulary – the words that make up the building blocks of speech. Of course if there was any justice in the world, it would have been called Tan's area, but I suppose Broca was the first to call Nature magazine and so he got his name on it. Really… scientists!

In 1874, Karl Wernicke identified another region of the brain which helps you choose the right words and put them in the right order. This became known as Wernicke's area (no surprise) and it's the part that gives you your sense of grammar. So, Broca's area will help you with the right words while Wernicke's area helps you put them in the right order. In the Star Wars film Return of the Jedi, Yoda seems to be having trouble with his Wernicke's area when he says ‘A Jedi knight I am.’ So Yoda, although able to levitate spaceships with the power of his mind is incapable of stringing a short sentence together.

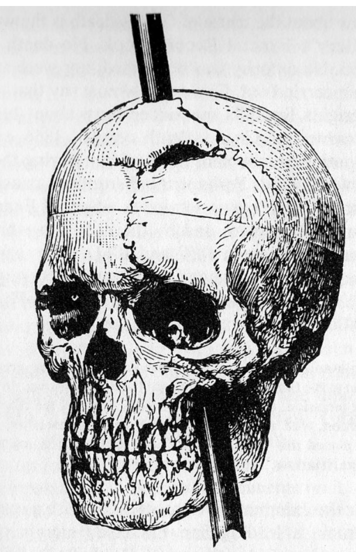
At around about the same time, in 1870, Julius Edward Hitzig started lurking around the battlefields of the Franco-Prussian war collecting fresh corpses (well, I suppose everybody needs a hobby!)

Hitzig discovered that the left side of the brain controls the movements of the right side of the body and the right side of the brain controls the movements of the left side of the body. He experimented on the dead soldiers by administering electric shocks to different parts of their brains to confirm his theory.

As a rule of thumb, this left/right function of the brain works for every part of the body. For instance, light entering the right eye is processed by the left hand side of the brain and of course it works the other way around with light entering the left eye. The only exceptions are the nose – smells sensed in the right nostril are processed by the right hemisphere of the brain and vice versa. The same is true of the ears. All this brings us neatly to the story of Phineas Gage.

In the latter part of the nineteenth century, Phineas Gage worked as a dynamite tamper on the railroads as they forged west across the great plains of the United States. His job was to ram sticks of dynamite into holes with an iron rod so that any tiresome obstacles, such as mountains, could be removed so they wouldn’t get in the way of J. P. Morgan’s profit margins. One day, a stick of dynamite went off prematurely and the iron rod shot through Gage’s head. Against all the expectations of the crowd of sightseers that gathered immediately following the accident, he survived. At the time it was thought too dangerous to remove the iron bar so it remained stuck in his head for the rest of his life.

Although Gage lived to tell the tale, his personality dramatically changed. Far from being the cheerful, happy-go-lucky chap he was prior to the accident, he became a thoroughly bad tempered and curmudgeonly individual who, unable even to find employment at MacDonalds, eventually ended his days as an exhibit in a freak circus.



Left: Phineas Gage and the cause of his personality problems.

The story of Phineas Gage illustrates the premise that different parts of the brain are responsible for different activities and processes.

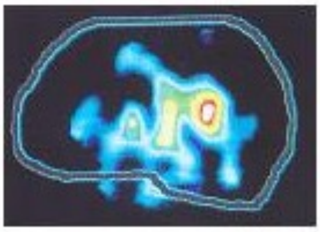
It has long been thought that the personality is mainly located in the frontal lobes. In America in the 1950's and 1960's many violent criminals were given frontal lobotomies, which meant having part of their frontal lobes surgically removed. It was found that felons who were subjected to this type of surgery became not only less aggressive after the treatment but most became extremely docile. Sadly this practice has been largely discontinued in the wake of opposition from the human rights lobby.

During the 1950's, neurosurgeon Wilder Graves Penfield started to map the conscious human brain by stimulating different parts of it by inserting low voltage electrodes to produce sensations of taste and music. Mainly he did this on patients who were conscious and often undergoing corrective brain surgery. Sadly, this practice is now illegal, but what fun it must have been!

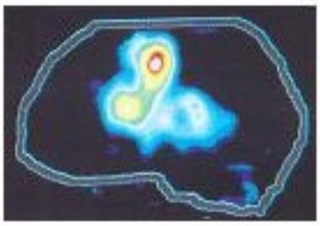
As recently as 1998, American scientists discovered the part of the brain that makes you laugh. A group of neuro-surgeons, having some time on their hands during an operation, gave mild electric shocks to part of a girl's brain (fun part) and she started giggling uncontrollably (irritating part.)

So in conclusion, we can safely say that different areas of the brain handle different tasks… There are areas that deal with language, visual processing, movement, sensation and thinking – but there is also a lot of duplication. For instance long term memory is located in the Thalamus and the Hippocampus whilst some memory is also stored in the Amygdale.

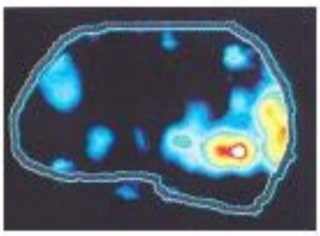
The images below, taken using a CAT scan, confirm the theory that different areas of the brain are assigned to different functions.



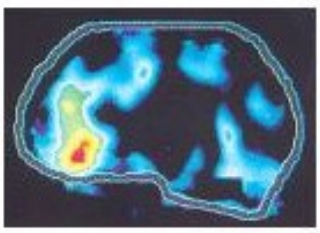
HEARING



FEELING



SEEING



THINKING

Oxygenated blood, by virtue of its magnetic properties can be tracked as it flows to the more active parts of the brain, where it is most in demand. Magnetic Resonance Imaging (MRI) and Positron Emission Tomography (PET) allow today's scientists to see thoughts actually taking place – they can see the red glow of fear erupting in the amygdale or the tell-tale firing of neurons as a memory is recovered, or the pleasure from emotions of love or a chocolate mousse.

The Cerebrum, the large brain, is divided into two hemispheres. No one really knows why this is, although balance is a strong contender. The cerebrum is the part of the brain that makes decisions, thinks, observes, plans, anticipates, responds, organises information, and creates and modifies ideas.

The Cerebellum, which means 'little brain' in Latin, is about the size of a pear and is also divided into two halves which help the brain balance and control the body's movements. It is the controller of ideomotor actions which means that it unconsciously deals with all the things we do automatically and without having to think about them, like breathing, walking, sweating, blinking and running away from Everton supporters.

The frontal lobes of the cerebrum help us to differentiate between fantasy and reality. This is of particular interest as it seems to 'switch off' during hypnosis. When a person enters hypnosis, the brain can be fooled into thinking that something which is purely imaginary is real and that something which is real is purely imaginary. Stage hypnotists tap into this function when they ask their subjects to perform imaginary tasks for the general amusement of the audience, such as forgetting their own name. The success of these stunts depends on the temporary suspension of the critical faculties which are located in the frontal lobes. Hypnotherapists perform exactly the same sort of magic when they persuade their clients that cigarettes will always taste foul in the future or that a spider is a figure of fun and nothing to be even vaguely concerned about.

The temporal lobes, also located in the cerebrum, are important because stimulation of these lobes can sometimes cause flashbacks or feelings of a 'presence'. People who have temporal lobe epilepsy very often report hearing voices or seeing visions. The Bible is full of such accounts. Before the condition was fully understood, the medical profession was understandably unenlightened as to its cause and people often confused the symptoms with genuine religious visitations. Saint Bernadette of Lourdes is thought to have had an episode of temporal lobe epilepsy when she had her vision of the Virgin Mary and the condition could explain St. Paul's epiphany on the road to Damascus.

Modern research seems to indicate that those with a religious disposition in the first place seem more prone to religious experiences during an episode of temporal lobe epilepsy. Every year in Jerusalem, Israeli police routinely take into custody people who, for a variety of reasons, suddenly become convinced that they are the Messiah. It must be blindingly obvious that the condition may be responsible for other hallucinatory incidences such as alien abduction experiences.

Neurologist Dr. Robert Persinger has carried out experiments in which volunteers have undergone an artificial kind of 'sensed presence' experience, some even hearing voices and in extreme cases, seeing visions. In order to induce these experiences, subjects are placed in a darkened room and blindfolded. A helmet with about a dozen small electro-magnets on the outside is then placed on their heads and when the machine is switched on, the shape and intensity of the magnetic fields within the brain are manipulated by means of dials on a circuit board until the desired effect is produced. These magnetic fields affect the electrical charges deep within the brain. Not everyone responds successfully though – Professor Richard Dawkins felt nothing – whereas some individuals respond very well.

Fascinated by this experiment, I decided to build one of these machines myself, using electro-magnets from old electric motors, a motorcycle helmet and a repurposed mixing desk I had lying around. Trying to recreate the conditions of Dr. Persinger's experiment as faithfully as possible, volunteers were blindfold and tied to a chair in my garage far from the prying eyes of the ethics committee. The experiments worked extremely well, but… the best results came from those people who already had a predisposition for fantasy and/or suggestibility.

About a third of the twenty or so 'volunteers' felt nothing at all while around the rest reported, to varying degrees, that they had the sense there was another person present in the room (there wasn't) or that there were several other people present. Only one person found the experience deeply unpleasant and threatened to sue, but in fairness he was the plumber who had just charged me £130 for bleeding a radiator and I had told him that the machine was a new type of personal sound system and o be fair, I did turn it up to maximum just to see what would happen.

What interested me most however, was the fact that suggestions given during the experiments seemed to take on a more profound meaning, and in one instance, a long lasting importance. Even after the machine was switched off and the experiment explained in a detailed debriefing, some of the volunteers went away feeling that 'a veil had been lifted' and that 'I will never look at the world in the same light again'.

The limbic system is also linked to religious experiences and feelings of being in the presence of God. Stimulation of this area can produce feelings of intense joy. In this emotionally charged state, people can become extremely suggestible. This often happens at large religious gatherings or Nazi rallies where the phenomenon is often linked to mass hypnosis. In these instances, individuals often succumb to extreme emotions and more easily become part of the lager organism of the larger group.

Stimulation of the auditory cortex can also produce hallucinatory 'voices' or other types of quasi-religious experience, particularly for those whose minds are already open to these ideas.

The two hemispheres of the cerebrum are bridged at the base by the Corpus Callosum, a large band of nerve fibres which connect the hemispheres and through which information passes from one side of the brain to the other. If you were to separate the roughly symmetrical hemispheres by slicing through the corpus callosum, you would behave like two completely different people, which would be very interesting. At least when you thought about a problem you would be able to get a second opinion.

Very rarely, some people are born with up to 97% of their brain missing – the condition is called hydrocephalus – and believe it or not, these people are able to function perfectly normally and are just as smart as everyone else. The condition is often unknown to them until they go for an X-ray!

Information gathered by the cerebrum is assembled and collated in the cortex before being transferred from the cerebrum to the cerebellum. Imagine that you are learning to play a musical instrument. At first, you really have to think about what you are doing – translating the meaning of the notes on the page into physical actions like where to put your fingers on the instrument and so on. These thought processes take place in the cerebrum but after practice they become relocated to the cerebellum and playing becomes second nature.Once the cerebellum is in charge, you can do these things much, much faster, more precisely and without consciously thinking about them.

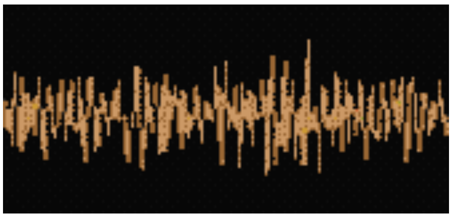
This exchange eventually enables you to play your instrument with proficiency, much to the relief of the neighbours. It also stops information overload – if we were consciously aware of every movement we make or every detail of every thought we think, our minds would be so cluttered with data it would be nigh on impossible to sort out the important stuff from the trivial. Our brains have evolved so that the cerebellum takes care of the general running of things and that leaves the cerebrum free to concentrate on the more important tasks.

The brain stem links the brain to the nerve highway of the spinal cord.The brain stem helps you sleep, but it's also your built-in alarm clock, sounding the alert when there's danger or when there's something of interest going on. The brain stem also remains vigilant when a person is hypnotised – like a sentry, ready to warn subjects if and when they are asked to do something they don't want to do, or if they are asked to do or imagine something they find distressing. So this part of the brain acts like a natural built-in alarm.

Depending on what sort of activity a person is engaged in, the brain as a whole will produce different 'rhythms' which can be measured.

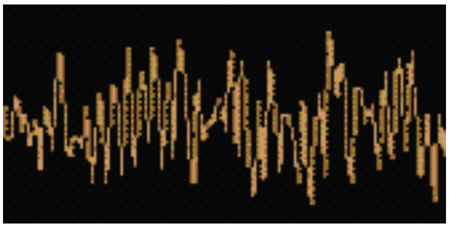
Beta Rhythm – more than 13 Hz:

Beta waves occur when a person is awake and alert and engaged in problem solving activity. This could be anything from doing a crossword puzzle to filling in your tax return to working out how much you can safely skim off the top before you draw attention to yourself. These waves are also seen during Rapid Eye Movement sleep (REM). REM occurs whilst dreaming – at least six to eight times every night. It also occurs in hypnosis.



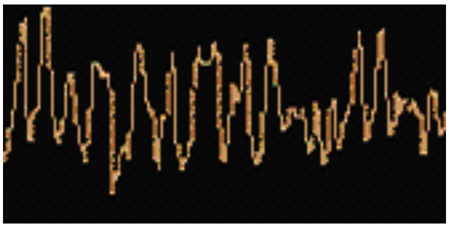
Alpha Rhythm – 8 to 12 Hz:

Alpha waves are usually present when a person is awake – the brain is thinking but in a relaxed way – listening to music, watching some mindless television soap opera etc. A person may be in a drowsy state, with their eyes closed. These waves commonly occur before you fall asleep. They also occur when you're engaged in performing familiar tasks. Many church goers fall into an Alpha state whilst repeating monotonous prayers they already know off by heart. The task is both comfortable and familiar and therefore does not require a great deal of concentration or cognitive thought.



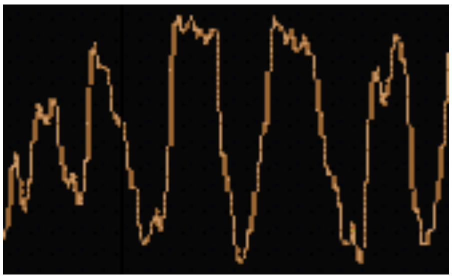
Theta Rhythm – 4 to 7 Hz:

The brain is feeling sleepy – Theta waves are more commonly seen in children rather than in adults. They can be detected in adults feeling frustration or with some types of brain disorders. They also are present during light sleep.



Delta Rhythm – 3 Hz:

Delta waves are present when the brain has fallen into a deep sleep and in people with severe brain disorders.



Information is processed in the brain by a series of chemical reactions which in turn produce tiny electrical charges between the neurons. Tiny pumps on the surface of each neuron exchange sodium and potassium – sodium is pumped out and potassium floods in, and it's this exchange of sodium and potassium that creates the electrical charge which passes along the Axon/Neuron wire. Axon/Neuron wires can be anywhere between one and 100 millimetres in length.

Located at the end of the axons are dendrites… between the dendrites are the synapses and this is where the electrical 'spark' between the neurons takes place. These transfers of energy are virtually instantaneous and create an even faster moving signal made up of an altered electrical charge.

In an average adult brain there are over one hundred billion neurons! If you were to try to count them, it would take you more than a thousand years and would be a complete waste of time. Each neuron has over five thousand branches. All are being constantly bombarded with signals and messages from the sensory world. Scientists believe that a thought can travel through these circuits in any order, moving through an almost infinite variety of different circuits each time you think it. That means there are a greater number of possible routes a thought can take than there are atoms in the known universe!

Try this experiment… concentrate on the feel of your clothes against your body. Until you actually thought about it, you didn't notice this sensation. This is because as you get used to certain sensations, the neurons stop firing. The same could be said of people who live near airports or in large cities. At first, they are woken up by the thunderous noise of jet aircraft taking off, or by the constant noise of heavy traffic, fire engines and the inebriated residents of some distant council estate staggering home, having missed the last bus and singing Viva España at the top of their voices. But, after a while, people get used to these sounds and hardly notice them, even when they are awake.

The sense of sight works in the same way. The Retina sends signals to the visual cortex which is located at the back of the brain. These are then interpreted in terms of shape and colour. When there is movement, this is important information for the brain. Movement is guaranteed to attract the attention! If you have ever tried to have a conversation when there is a television on in the corner of the room, you will know how easy it is to be continually distracted.

Young children become mesmerised by the moving pictures on a television screen to such an extent that they lose all interest in anything else they are engaged in doing or anything else that is going on around them – even their food (presuming of course you allow your children to eat dinner and watch TV at the same time).

Conversely, when you concentrate on something very hard, your brain blots out the vision from the corners of your eyes. It also blots out background noises to help you concentrate better on whatever it is you are doing. This ability to concentrate on one thing to the exclusion of all others is a fundamental component of hypnosis and it is known as 'Involvement'.

In everyday life, it is a combination of *all* the senses that help you comprehend what is going on around you.

With our eyes closed, we rely more on our other senses than we do normally. In hypnosis, a subject's awareness of their surroundings diminishes as more effort is diverted to concentrating on the auditory input of the suggestions given by the hypnotist. This process is helped by the fact that while the subject is in the hypnotic state – with the main sensory input of sight temporarily cut off – the sense of hearing perks up a little and helps the subject concentrate more on the suggestions, or the messages.

This is called 'Focus of Attention' and it's a very simple concept to understand. The more the attention is focused on a particular suggestion, to the exclusion of everything else, the more likely it is that the brain will absorb the information contained in the suggestion and the more likely it is that information will become permanently fixed in the mind.

People who find it easy to get lost in a book or get wrapped in their own imagination or fantasy world make very good hypnotic subjects because they are able to focus their attention to the exclusion of any and all other distractions. This sort of focus rivets the attention because the task is interesting.

Sudden shocks or unpleasant surprises can also focus the attention and these sudden attention grabbers characterise 'Peak Experiences' which stay in the mind permanently. Hypnosis itself is a peak experience and suggestions delivered under hypnosis are more likely to stick in the mind.

Repetition is a very simple technique used by hypnotists, politicians, advertisers and others who would manipulate our thought processes for their own advantage. Repetition reinforces ideas over and over again and it works because the more the brain hears a particular message, the more neurons and connections become allocated to that particular thought or idea. This also happens in the 'waking state', which is why advertisers like to repeat their messages. Hypnosis makes suggestions infinitely more compelling because in hypnosis, the attention is more focused than in the normal waking state. If an advertisement has a memorable slogan or a catchy tune, it's easier for the brain to remember it. This is why the ad for 'Shake and Vac' was voted the best advertisement of all time by the advertising industry. As silly as it was – a housewife singing and dancing while sprinkling scented powder onto the carpet and then vacuuming it up again – everyone remembered the ditty and that is after all what advertising is supposed to achieve.

In addition to suggestion, there is 'Conditioning'. A person can be conditioned or behave in a certain way more or less on demand. An example of conditioning would be getting them to feel queasy every time they reached for a cigarette, or elated every time they achieved great exam results.

To help explain the concept of conditioning we can look at an experiment carried out by a Russian scientist called Ivan Pavlov in the early part of the 20th century. Pavlov rang a bell every time he fed his dogs and very quickly the dogs learned to associate the sound of the bell with the food and so every time the bell was rung the dogs would start to salivate, whether or not there was any food there. In other words, he had conditioned the dogs to salivate when they heard the bell and not when they saw the food.

This is *the* classic example of conditioning. In 1904 Pavlov won a Nobel Prize for this astonishing piece of work. The runner-up was Mrs. Edith Poskitt of 42 Railway Terrace, Giggleswick, who noticed that her dogs salivated every time she called out 'Fido… Rover… din-dins!' to let them know it was feeding time. Sadly for Mrs. Poskitt, she neglected to record her findings and send them to Oslo. 'That bastard Pavlov' she always used to say.

The great humanitarian and philanthropist Joseph Stalin, when he was still a young revolutionary, stayed with a family in Vienna during one of his many exiles, and gave their young daughter a small bag of sweets every day. After a week, he asked her mother who the girl would run to if they both called her at the same time. Stalin won the bet – she ran to him. (*Stalin: The Court of the Red Tsar, by Simon Sebag Montefiore*).

Where I now live in Cape Town, South Africa, there are (amongst other things) a flock of guinea-fowl, one of which is lame. I feed them when I'm there and the lame one responds to the sound of me clicking my tongue and comes running on cue when it's in earshot. This took only three days even though, let's face it, guinea fowl are hardly the smartest members of the animal kingdom. But then one day… a miracle! The guinea-fowl brought his missus and nine new-born chicks when I clicked and this went on for about two weeks. Sadly, the neighbour's ginger tomcat got the lot one night. Such is the harsh reality of life on planet earth.

Another example of conditioning, and one which has provided much amusement to generations of psychology students, is an experiment done with rats. A rat is put into one end of a tube about a metre in length. At the other end of the tube is some food. The rat very quickly learns that the food will always be at the other end of the tube and consequently scurries down to it every time. However, when a glass barrier is introduced half way along the tube, the rat loses interest in the food because it quickly learns that it is inaccessible, even when the tube is unblocked. The students then hide the rat and pretend that it has got loose in the lab. Then the rat mysteriously reappears, first in the pub and then later on in the girl's hall of residence.

Pavlov's work has tremendous relevance to hypnotherapy. People are conditioned to smoke cigarettes because they always associate smoking with another pleasurable activity

– going out with friends, having a cup of coffee and so forth. People who have fears and phobias associate their feelings of fear with other related activities too. A prime example of this is the fear of flying. The fear always increases on the way to the airport and reaches a peak after the plane has taxied out and is about to start its take-off run. Fear of flying is an irrational fear as flying has been proved to be the safest form of travel. Fear of flying is actually a misnomer because it would be more accurate to describe the condition as fear of not flying.

So how does the brain learn all these things in the first place? It's because of something psychologists call 'Autonomous Abilities' – that is, the ability to do something without thinking about it. A good example would be learning to play the violin, which involves Practice Movement. Playing the violin involves practicing interpreting the crotchets and quavers on a sheet of music and putting the fingers of one hand down in the right place on the right string in the right order whilst the other hand moves the bow up and down over the same string with just the right amount of pressure and at just the right speed, over and over and over again. Practicing like this develops technique and develops pattern recognition. Practice improves dexterity and it increases the speed with which we can do things. In the end, practice makes perfect!

But there's more to it than just practice... It's not enough simply to learn – to learn properly we also have to apply principle, and learning and applying principle are very closely linked to memory.

We have already noted that the cerebrum is divided into two hemispheres. One hemisphere always ends up stronger than the other and this dominance decides whether a person will be left or right handed. Remember, each hemisphere of the brain controls the opposite side of the body. Babies are born with both sides of the brain equally strong – one side becoming dominant when the child is about two years old.

This is a picture of Conwy Castle. There are eight towers altogether. In seven of the towers, the staircases rise in an anti- clockwise direction, but not in the eighth, where the steps rise in a clockwise direction. This was so left-handed soldiers could defend that tower!

Right handed people read and write and perform arithmetical problems using mostly the left half of the brain. It’s the opposite way round for left-handed people who use mainly the right side of the brain to perform those functions. The left hemisphere of the brain also deals with talking aloud while the right side of the brain deals with more artistic pursuits such as drawing and painting.

To find out if you are left or right brained, pick an object about one metre away and hold up your index finger at a distance of about five centimetres from your nose. Lining your finger up with the object, first close your left eye, then your right. You will notice that with just one eye open, your finger will appear to move to the left or the right. With your dominant eye open, your finger will stay in line with the object. This is because with both eyes open, you see mainly with that eye. Right handed people usually have a dominant right eye and do their seeing with the left side of the brain. For left-handed people, it’s always the other way round.

The same applies to words, which are managed in the right hemisphere of your brain. Pitch and melody on the other hand are managed in the left hemisphere. Actors develop extra neurons and connections in their right brains because they need to remember their lines, while musicians develop extra neurons and connections in the left side of their brains that deal with sound and hearing which helps most of them play in tune. This is especially true if a person’s musical training is commenced at an early age.

In addition to all this, the right hemisphere of the brain sees the ‘big picture’ whereas the left hemisphere sees the detail. Here are a couple of examples;

The right side of the brain will interpret this drawing as a collection of dots but the left side should figure out that it is a picture of a Dalmatian. The same applies to the pattern. Is it a series of letter D’s, or a giant letter L?

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Thinking is the way the brain makes sense of the world. We have already seen that the brain has different areas for dealing with different tasks seeing, hearing, smelling, tasting, touching etc, but when thinking takes place, neurons are firing in all areas of the cortex.

Your level of concentration or even your emotional state can affect the patterns of brain activity. Neurons fire most of the time but, increased activity due to thinking is because the brain is also drawing on memories to help organise thought processes.

Performing multiple tasks at the same time is difficult but it can be accomplished with practice. A good example is that of an airline pilot. A pilot not only has to physically fly the aircraft – manipulating the control column, flicking switches and pushing levers whilst also interpreting the information presented to him from at least nine different instruments all at the same time. This information gives the pilot a three dimensional picture in his brain of where he is in relation to the ground and in relation to other aircraft.

Pilots are trained to interpret all this information not only as a three dimensional image in terms of height, distance and speed, but also to visualise the constant changes in the picture as they occur. He also has to talk to and take instructions from the air traffic controller. This communication with the control tower is in a language that only pilots, air traffic controllers and plane-spotters can understand because it's largely made up of industry jargon and sets of letters and numbers which give the pilot even more information about where he is supposed to be, where he actually is, and the procedure to be followed if he wants to get in ahead of the British Airways 747 who thinks he owns the sky. The pilot also has to take into account weather conditions such as wind speed and direction as well as knowing how to interpret the various maps used in aviation.

Percussionists also have to multi task, albeit in a different way. Drummers have to make each hand and each foot work independently of each other in order to produce an infinite variety of rhythmic patterns. This is extremely tricky and to begin with sounds like someone trying to build a shed, but can it can be mastered with practice.

Learning is a three step process. First – you are presented with a piece of information, second – you commit it to memory, and third – you apply principle. In other words, you use the information you have remembered to help you to execute tasks more efficiently and with greater ease in the future.

Life is one long learning process. You learn from what you see going on around you, from what you pick up from books, from what you see on television, from trying out new skills, from social interaction and of course from practice and experience. Learning is one of the ways habits are formed.

After the age of about thirty-six, your hearing, eyesight and sense of taste start to decline, although your vocabulary improves. This is one of the reasons people get better at doing crosswords as they get older. Patience also improves with age… you become more knowledgeable as you go through life and learn to apply your life's experience in order to make more sensible appraisals and decisions. But overall, once you learn how to do something, it quickly becomes second nature, just like learning how to ride a bicycle or hot-wire a BMW.

When you are born, your brain is only partially developed. If your brain was its full adult size, it would be impossible for your mother to give birth. The rapidity of the development of the brain of a new born child is astonishing! Remember – brain cells are created at the rate of over twenty thousand every second! Your brain doubles in size in the first six months of life as the neurons multiply and establish billions of new connections. You learn half of everything you will ever know in the first five years of life!

Within the first twelve months children can roll over, smile and copy expressions on grown up faces – they can pick things up with their hands and delight their parents by making their first intelligible sounds. They are also just beginning to learn to walk... By their second birthday they can walk and speak about 250 to 300 words. By the time they are three they can use up to 1,000 words and make up short sentences. They can feed themselves and learn to draw...

At four years old, their brains are now four times the size they were at birth. Now they are beginning to ask lots of irritating and embarrassing questions and by the age of five they can tell stories using about 2,000 words. At six years old, their brains are getting much more organised as more connections in your cortex are established.

The formative years are up to the age of around sixteen, and by this time their characters and personalities become firmly established, although some of these traits can still be changed. Around the age of sixteen or seventeen children start learning new behaviours – how to go out and get pissed, embarrass their parents, and probably have their first sex.

Girls and Boys brains develop in different ways. The parts of the cortex that deal with speech develop faster in girls than in boys. No one really knows why this is, but maybe that's why girls are always talking. One theory is that women have evolved this way for a purpose and again, that purpose is linked with the development of societies and the survival of communities and possibly even the species.

However, all this might be nothing more than a popular myth, because researchers at the University of Arizona and the University of Texas at Austin listened in to the everyday conversations of 400 college students and found that both sexes spoke roughly 16,000 words a day. However, 400 reasonably bright college kids isn't really representative of the population as a whole and doesn't take into consideration things like cultural differences, background, upbringing, and whether any of them are likely to be gunned down in class this year.

With all the men away hunting and gathering, the women were left behind in the village and had more time to experiment with language, or gossip – and gossip is one activity that helps to establish hierarchy. It is what is said behind your back rather than what is said to your face that establishes your position in society. Women have the ability to talk and do other things at the same time. This is called multi-tasking. Men find this extremely difficult and usually can only concentrate on one thing at a time. This is called being a man.

When women are found together in groups, they talk constantly – very often several will be talking at once, barely pausing for breath. When men come together in groups, only one will speak at a time while the others take time to consider the speakers judicious train of thought and the wisdom of his words. Men are comfortable in each other's company even when sitting together in silence.

Research from Yale University School of Medicine shows that men use only the left side of their brains to talk whereas women use both sides. However, boys are usually better at solving mathematical problems in their heads and are better at imagining solutions to three-dimensional puzzles whereas girls often waste time explaining to themselves how they will solve problems and puzzles, trying to put their thoughts into words. Some very gifted boys use only the right side of their brains to solve puzzles but on the other hand, girls are better at controlling delicate finger movements than boys, which gives them the advantage when it comes to putting the puzzle together.

Boys are better with maps than girls. They can more easily build a picture of the route in the right side of their brains but girls are better at remembering landmarks. Boys can remember whether it's the second or third on the left, but girls are better at remembering if it's opposite the post office or the petrol station. The only exception to this is when something is near a pub, in which case that information can usefully be incorporated into the directions given to a man.

Women use more of their emotional brains than men and I have found that in stage hypnosis shows, women are usually better at talking about a set topic than men. Men are normally better at performing physical actions than women, but overall, boys and girls are equally clever.

All this is very interesting but would be completely pointless if it were not for Memory – the function that helps us store and retrieve all this information.

Memory is located mainly in the Thalamus and the Hippocampus. The human brain stores information equivalent to the amount of information on a thousand CD's – each CD storing five billion bits of information.

Research carried out at Glasgow's Caledonian University shows that memory retention improves by almost 20% when the brain gets a glucose 'hit.' Glucose appears to improve the brain's ability to store new memories and recall old ones. In tests, young and middle-aged adults were given glucose supplements and this triggered memory cells in the hippocampus, which in turn led to an increase in memory activity.

Everybody has three memories – a short term memory, useful for phone numbers, directions, drinks orders and the like – a long term memory, useful for remembering your life story and all the lessons learned through life (this is located in the temporal lobe) – and a special memory which stores the skills that allow you to play your musical instrument or drive your new BMW at high speed through the city centre whilst being pursued by the police.

Each neuron pathway stores a particular memory. Some store memories of colour, others store memories of shapes or smells. Once the receptor molecule has locked into the transmitter molecule, a permanent change to the chemical events inside the cell takes place and this permanently alters the number of connections to or from the cell, and even the shape of the cell itself.

One of the functions of memory is pattern recognition – one of the skills that helps us anticipate. Anticipation gives us the ability to predict the future, based on the memory of all our previous 'what happened last time' experiences. Another word for anticipation is 'Expectation'.

Some people have extraordinary memories. Mozart for example could listen to an entire symphony just once and then write it out in full, getting every note right – and even the orchestration!

Generally speaking, women have better memories than men. Most women can remember every detail of every party they have ever been to including the specifics of who was there and what they were wearing. Men on the other hand usually have difficulty just remembering the party. Women are also uncannily capable of remembering every word uttered in an argument that took place fifteen years ago whereas men have usually forgotten all about it by the following morning.

Using a series of mild electric shocks, surgeons in the United States stimulated the brains of five hundred patients during open brain surgery (remember the brain itself has no pain receptors.) The stimulation of the temporal cortex produced a memory in some patients yet when they were stimulated twice in the same place, different memories were retrieved. When the brain was stimulated in different places, sometimes the same memory was produced. This is because the stimuli can activate different circuits even though they emanate from the same neuron.

We know that the brain contains all our feelings and emotions. There are six main types of feelings: happiness, sadness, anger, fear, surprise and disgust.

All these emotions have served our species very well as far as survival is concerned. For example, the feeling of disgust stops us eating rotten food or indeed each other (even in the animal kingdom cannibalism is extremely rare). When we lose a loved one, feelings of sadness remind us of our obligations to our fellow man, while the emotion of fear reminds us not to get into an argument with someone with a Liverpool accent and whose nickname is ‘Razors’.

Sometimes our feelings, especially strong feelings and emotions, can get mixed up. When this happens, it’s because a chemical imbalance has occurred in the brain. You can see this every year at the Oscars when a seemingly endless parade of over-emotional celebrities literally weep tears of joy as they are presented with the golden statuettes which guarantee the recipients a life free from any further financial hardship.

All our emotions are triggered by several different chemicals, so it’s not surprising that they get mixed up sometimes. This happens because the brain is literally getting mixed messages. Under stress, when the brain is working overtime, you can get your words mixed up and say stupid things. This is why, when running at an emotional high, people sometimes say and do things that they afterwards regret saying or doing in the heat of the moment. ‘Will you marry me?’ is one of the most common things people say that they later live to regret.

Here are some more examples of silly things some sports commentators have said when under pressure (with grateful thanks to *Private Eye* Magazine):

‘There's Moses Kiptanui, the 19 year old Kenyan who turned 20 a few weeks ago'

‘There is Brendan Foster, by himself, with 20,000 people!’

‘That's the fastest time ever run – but it's not as fast as the world record.’

‘Apart from their goals, Norway haven't scored.’

‘That would have been a goal if the goalkeeper hadn't saved it…'

So, emotions are really the result of chemical changes within the brain and although the brain produces these chemicals in minute amounts, their effect can be profound.

Dopamine is a natural opiate that seems to make your neurons more active and fire more signals. This chemical reaction enhances the emotional response, whether those emotions are of joy or fear. Dopamine is produced in the Reticular Activating System which is located in the brain stem. When we look at mass hypnosis, this reaction takes on an importance all of its own!

In young children the production of dopamine is easily triggered which is why they are easily scared. This is purely as a result of external stimuli which influence the way the inexperienced child sees the world at that particular moment. As you grow up, the Reticular Activating System calms down because your cortex gets more experienced and more adept at coping with imaginary monsters and things that go bump in the night.

The chemical Serotonin on the other hand, produced by the neurons linking the limbic system and the cortex, calms you down again. Serotonin makes you more level-headed, reasonable, prudent, relaxed and generally happier – it moderates behaviour; it makes you stop and think and helps you control your temper. It also stops you getting over-emotional.

The brains of young children are not so adept at coping with these chemical imbalances which is why they can go from laughter to tears and back to laughter again at the drop of a hat. Some women also experience problems controlling the hormonal imbalance brought on by pregnancy or menstruation, hence the seemingly endless erratic mood swings, irrational behaviour and their new found obsession with the idea that their partner is an uncaring slob who can't do anything right.

People with naturally low levels of serotonin find it difficult to control their temper and are more prone to violence. For those particular individuals, the bad news is that this is not a particularly effective defence in the courts, because the law understands that ultimately it is the reasoning centres of the cortex that make the final decisions about one's own behaviour.

When we are afraid, adrenalin is produced by the adrenal glands which are located above the kidneys. Adrenalin is pumped into the blood and the resulting sudden surge of energy readies the body for possible violent physical action – 'Fight or Flight.' Your lungs start panting in air – up to ten times more than usual whilst stored sugar pours out from the liver and into the bloodstream to feed the brain, which is now working overtime. Digestion stops as all energies are diverted to more important functions, for instance running away from the person who has difficulty regulating his serotonin levels.

Fat is dissolved and sent to the muscles to provide energy – the heart beats so fast it can become irregular, muscles lock and blood flows into the hands so that should the need arise, you are ready to grip a weapon. At the same time blood drains from the face so that any wounds you may receive won't bleed too much. Finally – and we have all experienced this at some times in our lives – the mouth goes dry.

These responses were developed hundreds of thousands of years ago as a way of helping our ancestors cope with an encounter with a sabre-toothed tiger but they are still as relevant today in preparing modern man for a Saturday night encounter with the kind of person who has no sense of humour and is on weekend leave from one of Her Majesty's establishments where he is normally resident because of a recurring history of serotonin deficiency. Now it's time for you to turn pale and your mouth to go dry.

The adrenal glands also produce a hormone called Cortisone. Cortisone prepares your muscles for action later on – sugar pours into your bloodstream and your brain suddenly feels more alert because of all the extra sugar and oxygen which cause the neurons to start firing like crazy, which in turn makes you feel nervous and jittery. All this stress can make people start to bite their fingernails – under stress the body craves a chemical called Keratin which is found in fingernails.

In the end, all this stress and strain can lead to depression. Depression is caused by a shortage of brain chemicals such as serotonin. The cure is both simple and effective – it involves relaxing by taking deep breaths. Breathe in and out slowly and relax… relaxing can make you feel better. Of course this is not really going to help if you are being pursued by a large woolly mammoth, but if you have the opportunity to give it a try, then so much the better.

You can correct any chemical imbalance just by doing this simple exercise, although it is unlikely you will persuade your assailant to do the same at the same time as being repeatedly punched in the face by someone who is now very definitely in breach of his bail conditions. Failing that, you could try repeating the words 'now then, now then… calm down, calm down!'

Listening to classical music can also make you feel better. This was proved by Austrian psychologist Manfred Klein – his favourite music was the Brandenburg Concertos by J. S. Bach. This of course is more practical *after* you have been discharged from hospital.

The brain is protected by layers of hair, skin and skull. There are also three layers called the Meninges which are in turn cushioned with 125 to 150 millilitres of clear fluid to absorb bumps. And a fat lot of good that will do you during your encounter, or attention focussing experience, in the pub car park.

As you get up in the morning, the brain sloshes forward in the skull and some neurologists believe that even this small shock can make some people bad tempered. In a car crash, the effect of the brain being thrown forward against the inside of the skull is far worse than any blow to the outside of the head. The shock can tear blood vessels and cause all sorts of damage which is hard to repair because the damage occurs inside the skull. The effects of injury depend on which part of the cortex is damaged.

Moving swiftly on, there are things that happen while you sleep that you are not aware of... even though sleep has an important role to play in the way we learn.

Most human beings spend about a third of each day asleep, although Margaret Thatcher said that she only ever needed four to five hours sleep each night. Mrs. Thatcher was one of those rare people who are driven by determination and strength of purpose, but for the rest of us lesser mortals, seven to eight hours sleep is about the norm.

The body and the brain need frequent and regular periods of rest so the Pineal Gland helps you to nod off by producing Melatonin which dampens down the activity in the cortex. The production of serotonin also helps reduce activity in the cortex.

The pineal gland produces melatonin in twenty-four hour cycles. If the brain is deprived of natural light and darkness, away from the normal cycle of day and night, the brain quickly adopts a twenty-five hour rhythm and the reason for this is so fascinating it definitely deserves a mention.

Hundreds of millions of years ago, at the very beginning of the evolutionary process, long before even our most distant ancestors crawled from the seas onto the land, the tides, pulled by the gravitational force of the moon, ebbed and flowed in a 25 hour cycle just the same as they do today. This built-in chronometer has been indelibly stamped on our genes since our ancestors were mere multi-celled amoebas. It's effect is as constant and unremitting for all the other creatures of the earth as it is for us homo-sapiens.

After the onset of sleep, nothing happens for about forty-five minutes as you drift from a light sleep to a deep sleep. This is when the brain is 'freewheeling' – the time when your mind is able to wander without the constraints of the outside world.

The sleeping brain produces Delta brainwaves and after about three quarters of an hour, your eyeballs begin to move under your eyelids. This is called Rapid Eye Movement or REM sleep and it always accompanies dreaming. When people are in hypnosis, it is sometimes possible to observe a slight fluttering of the eyelids as well as the movement of the eyeballs under the eyelids.

Thousands of people have said that when hypnotised, the feeling was very much like being in a dream – they were aware of what was going on, but felt too calm and relaxed to do anything about it. I often ask subjects, both at the end of my shows and after private sessions about their experiences, and their comments have provided me with lots of useful information.

While you dream, your brain pumps chemicals into your brain stem that block nerve messages to the muscles to stop your body acting out your dreams, which could be embarrassing. Your brain goes into REM sleep at least six or seven times during the night.

Sleep has a dual purpose. It gives your physical body, your muscles etc, time to recover from being used, although this physical regeneration has nothing to do with sleep itself. Overworked muscles recover after a period of rest and relaxation immaterial of whether or not that period is accompanied by sleep. Sleep is simply to give your brain time to sort itself out.

In other words, during sleep the brain collates all the information you have absorbed during the day. Sleep allows the brain to review and consolidate. The purpose of dreaming is to separate what is important from what is trivial, to sort out information and to add the day's new experiences to all your previous knowledge.

When we feel tired, it's the signal that the brain needs some rest – it needs some down time to reorganise itself. The first yawn is the telltale sign that you are not as wide awake as you thought you were! After about eighteen hours without sleep, reaction times slow from about a quarter of a second to about half a second, and then get progressively longer. This makes a person less effective in all sorts of ways. It can also affect judgment. Fighting fatigue at the same time as fighting a battle, or driving a car, is very definitely not a good idea.

Most people experience periods of micro-sleep which can last from a fraction of a second to twenty seconds. These micro-sleeps gradually get more frequent and longer in duration the more a person is deprived of sleep. Try pretending you're a student and stay up all night and see how you get on!

Sleep is as vital as food or sex for survival. More important, sleep is there to help you master various skills such as operating complex machinery, learning to play a musical instrument, learning poetry or learning how to drive a car. With the advent of more sophisticated and accurate ways of measuring brain patterns it is now possible to observe what happens during a nights rest, even right down to the individual neuron.

There are two distinct cycles of sleep – REM occurs only during dreaming and these dreams appear to be random images generated from previous experiences, mainly from the previous day. Non-REM sleep is when hardly any dreaming occurs. During Non-REM sleep we progress from light to very deep sleep. The latter stages are characterised by distinctive low-frequency electrical waves (Delta rhythm) also known as slow wave sleep.

We spend much more time in slow wave sleep during the first three hours of slumber than we do later in the night. Children go very quickly and deeply into slow wave sleep which is why they can sleep soundly in cars. As adults, we naturally get less and less slow wave sleep, which is why we find it more difficult to sleep as we get older, especially in cars or on aeroplanes – although surprisingly, we find it easier to fall asleep in a cinema. We thought nothing of sleeping on someone else's floor when we were students, but the thought of doing the same thing as we get older becomes inevitably unattractive. This is because we unconsciously know that it will be impossible.

In tests, scientists have now discovered that memory does not depend on REM sleep or the brain's interpretation of dreams. Some rare individuals experience little or even no REM sleep at all and yet are able to function just as well as anyone else. In the 1990's, with the advent of better and more accurate methods of measuring brain patterns, scientists began to unravel the mysteries of sleep.

A relatively new discovery is that Procedural Memory, that's any task that requires repetition and practice, depends on the amount of REM sleep a person gets. Declarative Memory on the other hand, for instance remembering dates or plain facts, is apparently not affected by the amount of REM sleep.

In experiments, given a simple task, for example playing five notes on a keyboard with the left hand, performance improved about 60% to 70% after about five minutes of practice. When these tasks were performed again later in the day, there was no significant improvement but when the tasks were performed again after a good night's sleep there was a significant improvement. Participants were able to do them 15% t0 20% faster and with 30% to 40% more accuracy.

The greatest improvement was found in those who spent the most time in REM sleep. Other types of procedural task that depended more on visual or perceptual abilities required periods of deeper sleep or slow wave sleep as well as REM sleep.

Sometimes just an hour's sleep made a big difference while other times a whole night's rest was needed. The latest hypothesis is that different types of memory need different types of sleep and this makes perfect sense because different types of memory are located in different areas of the brain.

Sleeping on a problem often gets better results. It's as if the brain has had time to assemble all the relevant information and put it into some kind of order to make it more readily understandable. In one experiment, volunteers were given a mathematical equation to solve. Those volunteers who 'slept on it' performed significantly better the following day.

A study involving rats has shown that the same neurons that fire in the rat's brain when it's trying to find its way round a maze fire again during the following period of REM sleep. To put it another way, 'neurons that fire together, wire together.' In other words, once the neurons have been allocated to that particular memory, they store the memory permanently. This happens not just during normal sleep, but during rest periods throughout the day, which is why we are better able to complete a crossword if we leave it and then come back to it an hour later.

In one experiment, a group was given a video game to play in which objects had to be 'captured' on the screen by moving a mouse. A slight bias was introduced to the speed and motion of the cursor to make the exercise more difficult. Half the group slept between sessions, the other half did not. Among the sleepers, the larger the slow waves were during sleep, the more able the volunteers were to compensate for the bias the next day. You can test this theory out on yourself, or even a small group of volunteers. Right-handed people are fairly adept at using a computer mouse with their right hands, but trying to use the mouse with your left hand is a slightly trickier proposition. Have five minutes practice and then try again a little later in the day. Then try again the following morning and see how you do.

It's now thought that all this happens because, rather than strengthening the connections between the neurons as happens during the day or during REM sleep, the process of slow wave sleep actually weakens connections. In order to continue making connections, the brain would use up all the energy available to it, so some connections must be weakened and this happens during slow wave sleep. Normally the body uses about 20% of its energy making connections. The weakest connections drop out so that the brain has space to learn something new the next day.

Believe it or not, Forgetting is an important part of memory! Forgetting not only helps the brain to free up space, but also to conserve energy. Some scientists believe that the more efficient a brain is, the better the information is collated and organised, and the faster its owner is able to think.

It certainly seems that sleep is a series of repeated cycles of pruning and strengthening of the neural connections which enable you to learn new things. That all this happens during sleep is almost certainly because that is the most efficient way to do it. A good analogy would be the way cleaners move in to the office only once the rest of the staff have gone home.

All this is of enormous significance when talking about hypnosis and the retaining of hypnotic suggestion. Experience suggests that the brain absorbs the information or suggestions presented to it a lot more readily if the subject is in that beautifully relaxed state we call hypnosis in the first place. Add to that a short period of rest before returning the subject fully to the waking state again at the end of the session and the desired result seems to be much more concentrated.

There is more to REM than just the physical manifestation of dreaming. REM can also occur in the waking state. In fact many scientists believe that REM is possibly a type of wakefulness or even non-wakefulness. During REM sleep, the brain may not be totally unconscious at all. A meaningful sound, for example hearing your name whispered, will generally cause you to wake up whereas meaningless sounds, an aeroplane flying overhead or a car passing by, will not. Important or significant sounds on the other hand – a baby crying – will also cause us to awaken.

So even during sleep, the brain retains the ability to discriminate between meaningful noises and meaningless noises and yet some dreams can be so vivid, even though they are often surreal, they do not cause us to wake up. There is little or no increase in pulse rate or breathing no matter how emotionally charged a dream may be and no matter how violent or frightening our dreams can sometimes be. The level of fight and flight chemicals such as adrenalin and cortisol remain unchanged.

When the brain is dreaming, it is free from the usual constraints imposed upon it by the reasoning centres of the frontal lobes, which goes a long way to explaining the brain's disjointed conjunctions and frequent leaps of imagination. This is precisely what happens during hypnosis but, the addition of pertinent external suggestions makes sure that the brain remembers those instructions.

Beware though of trying too hard to interpret dreams. Books that promise to unravel the meaning of your dreams must be viewed with the utmost suspicion. All too often, the interpreter of the dream is more prone to fantasy than the dreamer! There is absolutely no evidence to support the idea of universal symbols in dream imagery. Such notions are no more scientific than palm reading or astrology.