

# you can learn to remember

Change Your Thinking,  
*Change Your Life*

Dominic O'Brien



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Dominic O'Brien is renowned for his phenomenal feats of memory and for outwitting the casinos of Las Vegas at blackjack. He has won the World Memory Championship eight times, holds a host of world records and was named Brain of the Year in 1994 and Grandmaster of Memory by the Brain Trust of Great Britain. He is President of the World Memory Sports Council. His books include *Learn to Remember* and *How to Develop a Brilliant Memory Week by Week*.

This book is dedicated to everyone who takes part in mind sports.

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Acknowledgments

“Hi, Dominic. How come you’re entering this year? I hear you’re forty-two years old.” This was the question asked of me by a seventeen-year-old American student on the first day of the 1999 World Memory Championships. I was told that he had been training his memory for six hours a day for the past six months and was in London for one reason and one reason only: to become World Memory Champion.

Although I believe his opening question was part gamesmanship, many people would argue that this was, in fact, a fair comment. A bright, seventeen-year-old college student should certainly have the edge over a forty-two-year-old codger like me. After all, isn’t the memory capacity of a human being supposed to decline with age?

Up until 1988, if someone had asked me that question, I would certainly have answered “yes”. In giving that answer, I would have been echoing a popular misconception about memory – that old age and forgetfulness are synonymous. But, in 1988, I was to witness an event that would change my life. I watched a man called Creighton Carvello memorize a randomly shuffled deck of playing cards in just under three minutes – a feat of memory which put his name in the record books. I was dumbstruck. How could anyone connect 52 unconnected pieces of data together, perfectly in sequence, using nothing but their brain, in such a short space of time? Inspired and fuelled by a burning desire to uncover Creighton’s secret, I armed myself with a deck of cards and began a three-month investigation into the potential of my own memory. What followed was an object lesson in accelerated learning. A process of natural selection took place as I threw out ideas that failed and refined techniques that produced results. As each day passed I felt as though I was awakening a giant within me. For the first time in my life, not just my memory, but also my powers of concentration and imagination, were beginning to reveal a potential that I never before realized they had. Unwittingly, I was discovering the art of memory and memory techniques as practiced by the ancient Greeks more than two thousand years ago.

## setting your sights

On the first day of your memory training, you may remember only two or three items from a list. By the next day, you may recall as many as 10; by the following week, 20. Here are a few world records to aspire to!

In 1999 I memorized the order of 18 decks of shuffled playing cards (936) in one hour without a single error. In 2002 at Simpsons-In-The-Strand, London, I memorized a random sequence of 54 decks. All 2808 cards were shuffled into each other and I had only a single sighting of each card. I recalled the entire sequence with just eight errors. This is the current world record for the most cards memorized after a single sighting. Ben Pridmore holds the current record for the fastest time to memorize one pack of 52 playing cards, which he did in 24.68 seconds in 2008.

After three months of memory training I felt that I had been given a new brain. Soon after, I was entering the record books myself by memorizing not one, but six randomly shuffled decks of playing



cards from a single sighting of each card. While I was amazed and impressed by my own brain capacity, I felt at the same time immensely bitter that I had never been taught these same levels of mental agility when I was student struggling with examinations.

As a child, I was diagnosed as dyslexic. In addition, I was described as having an inability to concentrate on and remember what my teachers were saying. As a result, I did not shine academically and I left school at sixteen. What a shame that I was never shown the techniques described in this book. Even today, when we know comparatively so much more about the brain and the processes of learning, children are not taught how to learn effectively. Why? I have to confess that the answer to that question escapes me.

For the past few decades we have been concentrating on toning our bodies to make them appear beautiful; and we have been tuning our diets and lifestyles to keep ourselves physically healthy. With the advent of a new millennium, it now seems appropriate that we start nurturing, exercising and keeping healthy the command and control centre of our physical selves – the brain.

My hope is that by reading the text and experimenting with the exercises in this book you too will discover the giant within you – and what a giant!

And, by the way, that forty-two-year-old went on to collect a sixth World Memory Championship title.

**Dominic O’Brice**

# a brief history of memory

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from ancient times to the modern age

We may regard memory as one of humankind's oldest arts. To our ancient ancestors, it was not just a useful aid to survival, but an integral part of daily life. In the absence of the printing press, memory was the slate on which history was recorded. This was how we sorted information to help us make sense of the world. Reference devices were more primitive as well as thinner on the ground, so if facts and figures were to be at the fingertips of the ancients, they had to be remembered – a job for intellect and imagination. Throughout this early period of history, a good memory was a prerequisite for success: epic poets, notably Homer, memorized their works long before they were ever written down; and politicians, theologians and philosophers persuaded their audiences by delivering effective and convincing speeches, the memory cues for which were visualized colourfully in their heads. In this chapter we look at how memory has been used and understood through the ages.

As children, and even as adults, some of the most wonderful stories we hear are those of our own ancestry – tales that have travelled along the branches of our family tree like an army of determined ants. With each retelling, slight changes may be introduced – perhaps an embellishment or exaggeration to hold the wandering attention of a restless young listener, or an invention or two to bridge an awkward gap in the known facts. This is how memories are polished to make them smooth and easier to pass on to others. Yet the basic body of information usually remains broadly intact. By listening to dozens of stories, we accumulate a knowledge of our past. We may look at old family photographs, but without the context that memories – whether first- or second-hand – supply, such physical records are merely visual ciphers.

If we go way back in time, before the invention of the personal organizer, before we had diaries or even writing, we revisit an age when oral tradition was the only method of passing memories from one generation to the next. Anything not recounted for the benefit of others would disappear from the collective consciousness, forgotten for ever. Hence, enormous importance was placed upon memory among the ancients – it was recognized that without memory and reminiscence the cultural heritage would be lost. There were a few libraries in ancient Athens, and there was also a limited book trade, but these were no substitute for a wise man with a good memory.

We all have a vague image of the great epic poet Homer, whose feats of oral storytelling were no less heroic than the Greek and Trojan warriors whose stories he told. Homer relied on certain well-worn poetic formulae, improvised around a body of familiar material, and may even have used writing as an ancillary aid, at least for the Iliad, which consisted of 16,000 verses and would have taken four or five long evenings to recite. Yet there is no doubt that a spectacular memory lay at the heart of his skills as a performer.

Homer's great epics would have been somewhat fluid until in due course they were committed to writing. By contrast, in the Vedic tradition of ancient India it was believed that any inaccuracies in the chanting of any of the sacred hymns of the Rigveda would cause an imbalance in the cosmos, with dire consequences for humankind. In order to avoid such a catastrophe, Vedic priests carefully honed their memories so as never to make a mistake, and this has resulted in a highly unusual phenomenon: scripture, born out of oral tradition, that is believed to be very close to its original, spoken form.

Storytelling is a natural way to spend long winter nights in a village, which is one explanation, but when we pass into the Middle Ages, for the myths of northern Europe – extended tales of gods, giants, dragons and strange transformations, whose origins are lost to us but certainly belong to an oral tradition. The extreme nature of the subject matter, with its grotesque and magical episodes, made it perfect for memorization – an obvious link between the surreal and the memorable that operates in the most effective memory systems today. After all, what could be more vivid than Ragnarok, the last great apocalyptic battle between gods and giants which in the mythology of the Norsemen marks the ending of the world? Once heard, such tales could scarcely be forgotten.

**M**nemonic – the word we use for a device that aids the memory – is related to the name Mnemosyne, the Greek goddess of memory, who was said to have known everything that is past, present and future. She was believed to be the basis of all life and creativity (an association derived from her role as the mother of the Nine Muses, who were the inspiration for all aspects of literature, science and the arts). Moreover, myth tells us that if a mortal were to drink from Lethe, the river of Death, all his or her memories would be lost for ever. From these mythic associations we can deduce that for the ancient Greeks memory was the fount of inspiration, and that its loss was synonymous with death – making it a faculty to be held in the highest esteem.

The so-called “father” of memory training was Simonides of Ceos, a Greek lyric poet who lived during the mid 5th–6th centuries BCE. Having delivered a speech at a banquet, Simonides was summoned with a message that two men were waiting outside to see him. As soon as Simonides emerged from the building, the structure collapsed, crushing everyone inside to death. (The two men never appeared, but were said to have been the twin gods Castor and Pollux, who saved Simonides because he had praised them in his speech.) The bodies were too damaged for the families to identify, but by thinking back to where each guest had been seated during the banquet Simonides determined who was who.

In one stroke, Simonides had demonstrated his first principle of memory – that of locus, or place. By attaching images of what we need to remember to specific places, such as the rooms of a house or the chairs around a dinner table, we impose a logical structure on a group of items that are otherwise unrelated, thus making them easier to recall. To remember any sequence of data (be it names, a shopping list or points in a speech), a practitioner of the locus technique would mentally retrace their steps through the place in which they imagined the information had been stored. (Interestingly, the English word “topic”, meaning a subject or theme, is derived from the Greek *topos*, a place.)

*A great and beautiful invention is memory, always useful both for learning and for life.*

DIALEXIS 400BCE

Although the Greek texts on memory are believed to have been lost long ago, the techniques they taught are preserved in Latin texts written between the 1st century BCE and the 1st century CE (see [p.18](#)). From these we find that the Greeks established and developed many guidelines to ensure the reliable operation of their locus method. For example, they devised the idea that the locus should be somewhere familiar to the memorizer, and that people and actions should be used as much as possible to make any visualizations deposited in the locus more memorable. They believed that the senses had a strong role to play in memorization, especially sight. And the philosopher Aristotle is said to have recognized the importance of association – making connections in the mind, which enable us to take short, logical steps when storing and retrieving a memory. We will come across all these ideas later in this book – because each of them remains relevant to memory enhancement today.

The ancient Romans, like the Greeks before them, attributed prime importance to memory skills. Citizens were greatly impressed by the memorization feats displayed by trained orators, and were quick to see its value in the political theatre of the times. They believed that memorization was a fundamental component of rhetoric – without memorizing the structure of a speech, how could an orator make an impassioned plea or convincing argument?

Perhaps the most famous Roman to write about memory was the great politician and orator Marcus Cicero (106–43BCE), who helped to bring Greek teachings on memory to the Latin world in his work *De Oratore* (“On Rhetoric”). Quintilian (c.35–c.95CE), too, wrote an influential work called the *Institutio Oratoria* (“The Fundamentals of Rhetoric”), in which he applies the principles of the *loci* (see p.16) to a Roman villa. However, the most complete record of classical memory techniques appears in the *Ad Herennium* (c.85BCE), which predates the Cicero and Quintilian texts – it is said to have been written by a young (unnamed) boy. The techniques described in all three works draw largely upon those of the Greeks, but the *Ad Herennium* makes a unique, important distinction about types of memory, which both Cicero and Quintilian maintained: each of us has natural memory (our innate ability to memorize) but this can be improved through artificial memory – that is, memory techniques. According to Cicero, we all require our own individual levels of help from artificial memory. He himself had a good memory and could orate non-stop for three hours at a time, but he claimed that even his memory had to be supplemented by artifice.

During the Middle Ages a new perception emerged of the benefits of learning memory skills. The scholastics (medieval academics) adapted classical memory techniques to teach religion and ethics. The missionary Matteo Ricci used memory training as a vehicle to teach Christianity to the Chinese. Closer to home, the purpose of remembering the past was to inspire prudent conduct in the present and future. In addition, imagery was seen as important in bringing to life the vices and virtues – many of the preachers used vivid details during their sermons. These images were easy to lodge in the minds of listeners, to keep the hope of heaven, the fear of hell and the lessons of the Church uppermost in people's minds.

## Giulio Camillo's memory theatre

During the 16th century the Italian philosopher Giulio Camillo achieved great fame for his memory theatres, the purpose of which were to awaken the mind to the memory of lost divinity. Instead of simply describing an imaginary theatre, he conceived, designed and built actual, wooden ones and exhibited them throughout Italy and France, where they stimulated a huge amount of interest.

Each theatre was large enough for two people to stand on its central stage, and the audience chambers were filled with ornate columns and statues of the gods, to represent "all that the mind can conceive and all that is hidden in the soul". Camillo claimed that a speech worthy of Cicero could be memorized by mentally placing its key points on the statues and columns in the theatre.

During the Renaissance, with its resurgence of interest in classical traditions and its general spirit of humanistic inquiry, there was a blossoming of interest in memory as well as the arts and sciences. Memory techniques were no longer the sole province of religion – in fact, the pendulum had swung back, and some people even considered these methods to be the Devil's own work. Memory theorists such as Giulio Camillo (1480–1544) and Giordano Bruno (1548–1600) adopted Plato's theory that through memory human kind could transcend life and death and join with the divine. They believed that by using memory we could understand the mind of God and interpret the order of nature. Camillo invented a series of elaborate "memory theatres" (see box, p.19), while Bruno stated that the key to reaching the divine was in the organization of the mind and its locked memories. Bruno devised many memory systems, finally completing a series of memory wheels. These wheels were seen as microcosms of the heavens, and showed the orbits of stars and planets. On them he placed symbols of the arts, languages and sciences, and used his sensory associations to lodge images and facts related to these symbols in his mind. Then, while he observed the sky, the images he had associated with the heavens would be committed to memory and the brain would make order of the world. Branded heretic, Bruno was burned at the stake in 1600. In the ensuing centuries, as scientific endeavour rose to prominence, the art of memory no longer commanded such intense interest, yet the use of memory techniques never fully disappeared. In the eighteenth century, the Age of Reason, people sought

understand how the world worked. The emphasis was on discovering the harmonious system that lay behind nature and human mind. The study of memory became part of a general investigation in biological science. People concentrated on discovering how the brain retained memories. The scientific preoccupation meant that memory techniques involving creativity were largely rejected and the idea that a good memory was a mark of brilliance began to falter.

*Children learning geography might be able to tell the names of every known tribe in Africa or every petty island in the Pacific, without knowing the name or course of the river which ran through their respective towns.*

AN ENGLISH SCHOOL INSPECTOR'S REPORT 1846

In the nineteenth century, memory was seen not so much as a mysterious and spiritual phenomenon but as an empty vessel that could be filled by mechanical learning and repetition of facts. This is the view behind the popular image of the Victorian schoolmaster, driving facts into his pupils' minds by hammer blows of repetition. Rote learning became the basis of educational systems (and, to some extent, still remains an important factor in schools today). This reflected an ethic of hard work, an unwillingness to believe in shortcuts, and, in the great age of scientific and industrial advance, profound suspicion of the imagination.

The twentieth century has seen a shift in the study of memory. Instead of looking for ways to improve our memories (for example, to build skills that will further our political ambitions), scientific advances have taken us toward a better understanding of how memories are formed and stored in the brain. One of the most remarkable memory studies was undertaken by the Russian psychologist Alexander Luria between 1920 and 1950. His subject was a journalist named Shereshevsky, known simply as “S”, who confounded his colleagues by never taking notes at editorial meetings. He did not need to: he could remember every word, name, date and telephone number that he was told. As Luria tested S with increasingly complex data, all of which S could remember years later, it transpired that S accomplished his amazing feats by translating everything he heard into strong mental images or sensual experiences. But S was not doing this purposely – he had a condition called synesthesia, in which the boundaries of the senses sporadically become blurred, so that he might read the word “door” and experience a salty taste or see the colour red. The condition goes some way to proving how using the senses during memorization can create a series of imaginative pegs on which to hang pieces of information.

Since S’s time, psychologists have studied many hundreds of other subjects, some with unusual memory defects or abilities, most with normal memory function and capacity. Their research has yielded several theories on the way in which memory works. Although many aspects of memory physiology remain a mystery, we are increasingly aware of how well designed were the techniques used by the ancient Greeks and Romans – how well adapted to the functioning of the human brain.

Recently, perhaps the most influential development in memory has occurred not in the human mind but in machines. Our memory skills have become neglected as we increasingly rely upon external means of recording information – from the video to the personal organizer. We rate our computers by the size of their “memory” and the speed with which they access it. We marvel at the versatility of the internet. Yet we neglect to realize the full potential that our own brains possess. Memory skills are not taught in schools, yet memory is still tested in examinations. Most people do not know that memory can be extended by techniques anyone can master. We must look back to the ancients and revive their faith in the mind.

## The Memory Chip

One distinction between human and computer memory is the relative ability of each to evaluate information. Once a computer has stored data, so long as it is given the appropriate retrieval cues, the computer will bring back that information perfectly in its most recently inputted form. In human memory, the information that we store and retrieve is subjective – it is susceptible to mood, opinion, upbringing, and a host of other social factors.

One other difference between computer and human memory is our ability to remember layers of data in the same mental “document”. In a computer’s memory, of course, once data is overwritten, that information is lost for ever.





In the 4th century BCE, the Greek philosopher Plato alleged that memories were etched on our brains like the scratches of a pointed stick in wax. Eventually, each etching would be worn away and replaced by something new. The delightful simplicity of this theory belies the intensely intricate brain functions that enable us to memorize, retain and recall. Despite vigorous scientific research during the last hundred years, memory remains a mysterious, awe-inspiring phenomenon – a wonderful maze in which surprising self-discoveries lie in wait for us if we are prepared to stretch our minds to realize more of their potential. In this chapter we look at the basic physiology and psychology of memory in the context of the brain as a whole. Of course, we do not need to know how electricity works to be able to switch on a light. But learning something of the science awakens us to the miraculous gift of memory, for which we should all be thankful.

Memory has always been vital to our survival. Early nomadic humans needed to remember where sources of game, nuts and berries were plentiful, and where they could find shelter in winter. Perhaps most importantly, they needed to be able to recognize faces to determine whether an approaching figure was a friend or foe. Our memory has evolved alongside other facets of our intelligence and the brain itself. Although the brain is an extremely complex structure, a simplified overview of some of its regions and functions can provide a useful background to how our memory works.

The average adult brain weighs between 1,000 and 1,500 grams (2–3lb) and has the consistency of a soft-boiled egg. It serves as a command post and the processing centre for our primary physical and cognitive functions, including movement, speech, thought and perception. It is also the powerhouse of memory.

The lower part of the brain contains the brain stem, connecting the brain to the spinal cord. Attached to the brain stem is the cerebellum, which controls the body's movements. Above the brain stem is the thalamus, containing the limbic system – thought to affect our motivation and emotions. Just below the thalamus is the hypothalamus, a pea-sized region, which maintains the body's temperature and chemical make-up; it also helps control sleep and the emotions. Collectively, the thalamus and the hypothalamus are known as the midbrain. The higher, more complex functions of the brain (the ones that make us uniquely human), take place in the upper region of the brain: the cerebrum. Memory, language and creativity are some of these higher functions.

The cerebral cortex, the layer of the brain that covers the cerebrum, is the most important region as far as memory is concerned. The cortex is large and covered with furrows and ridges, which greatly increase its surface area so that it can hold a greater number of cells. Although the cortex comprises only 25 per cent of the brain's total volume, it contains 75 per cent of the brain cells – known as neurons. Primarily involved in integrating and processing sensory information, the cortex contains two large regions called the frontal lobes, which are believed to help us store and recall memories. The lobes are also associated with our emotions, personality and intelligence.

Altogether, the brain consists of some 10 billion neurons. Each neuron reaches out to one or more other neurons using minute fibres known as axons and dendrites every time we undertake any sort of mental activity. There are recognizable groups of neurons in the brain, but in principle a neuron can communicate with any other brain cell to form a thought or memory, or to precipitate a course of action. Every time we use our brain to make a memory, certain neurons transmit electrical impulses at lightning speed along their axons. The impulses are picked up by the dendrites of other cells – forming a type of electrical circuitry in the brain.

Each neuron may have hundreds of dendrites. Between each dendrite and each fibre at the end of the receiving cell's axon is a tiny gap, known as a synapse. When we use our brains, the electrical impulses sent along the axons cause messenger chemicals, called neurotransmitters, to be released from the axon of one neuron and flow across the synapse to the dendrite of the adjacent neuron. Different types of neurotransmitter carry different types of message – for example, serotonin acts as a natural painkiller and dopamine inhibits some of our movements. In addition, there are two types of synapses: excitatory synapses, which stimulate an electrical impulse in the next neuron, and inhibitory synapses, which prevent the electrical impulse from taking place. Together they control the unceasing activity of the brain, which is firing billions of impulses at any given moment. The action of the synapses

regulating brain activity is largely responsible for how we encode our memories.

~~Membranes called meninges protect the brain. They are surrounded by the cerebrospinal fluid which cushions the brain against the skull, and they also supply the brain with oxygen and nutrients. Our brains need a constant supply of proteins, enzymes, salts and other molecules such as glucose and calcium ions to manufacture the neurotransmitters, to enable the axons and dendrites to extend towards each other and for memories to be laid down. The brain's constant functioning means that it requires a great deal of oxygen to keep the neurons alive. The brain claims only three per cent of the body weight, but it uses 20 per cent of our oxygen intake.~~

*As for the brain, it is all mystery and memory and electricity.*

RICHARD SELZER B.1928

We recognize people in an instant, without having to think about the distinguishing features that make such recognition possible. Birdwatchers identify birds from a distance in a similar way, by what the term “jizz” (adapted from General Impression by Shape and Size). Human “jizz” may comprise not only the obvious components of the face, but also more subtle characteristics, such as a walking with a slight hunch, a flick of the head, the ways the hands hang from an undersized jacket. This exercise is designed to show how the slightest clues clinch recognition, in a way that demonstrates the extraordinary power of the brain as a processing tool.

- 1. As you walk around your local neighbourhood, look for people you know by sight. Scan around you and look at quite distant figures. You are certain to pick out familiar figures – even if you are not actually acquainted with them.*
- 2. Itemize the features that make such figures recognizable. What is the farthest distance over which you can make a confident identification? You may be surprised at your powers of recognition – which are dependent on memories stored unconsciously in the brain.*

The cerebrum or upper part of the brain – where memories and skills, such as language, are situated – is divided into two hemispheres, the left and right. The left brain controls the right side of the body while the right brain controls the left side, although no-one can explain why this is so. A thick network of fibres, called the corpus callosum, bridges the gap between the halves, allowing them to communicate with each other. If this bridge is destroyed, the subject's awareness of the body is totally divided – so, the left brain continues to process the experiences of the right side of the body, but the right brain has no knowledge of the actions, experiences or sensations of that side at all; and vice versa.

Scientists once believed that the left and right brains governed different mental functions. But a more accurate view is that each hemisphere processes information in a different way. In most people the left brain is more specialized in “serial processing” – analyzing information in a linear fashion, one piece after another. This makes it ideal for hearing and remembering speech, as well as processing numerical information, and logical problem-solving. The right brain excels at “parallel processing” – synthesizing several pieces of information at one time into a coherent whole. It is better suited for recognizing and remembering pictures, physical features and emotions. Some say that the left side of the brain is the analyst and the right side the aesthete. Epileptics who, in the 1960s, had operations to sever the corpus callosum subsequently “forgot” how to write with their left hands and how to draw with their right (just as we would expect: each hand is controlled by the opposite hemisphere).

However, the distinction is not clear cut: the left brain can work as a parallel processor if it needs to, and the right brain is capable of linear analysis. Nevertheless, specialization of the two hemispheres begins early in life and seems to be genetically pre-programmed. Measurements of electrical activity in the brains of newborn babies show that the left brain responds to a click and the right to a flash of light. In addition, the level of logical/creative activity in each hemisphere varies between the genders. Women's brains tend to be more flexible than men's – if a woman's left hemisphere is damaged, she loses less of her verbal ability.

To use our brain, and therefore our memory, to maximum capacity, we need to engage both sides of the brain in all we think and do. Most of the time we manage this naturally. For example, if we play a musical instrument, our appreciation of the music takes place in our right brain but recollecting the tune and the actions required to play the instrument takes place in the left brain. Musicians who have suffered injuries to their left hemisphere can still appreciate music, even though they have lost the ability to compose, play an instrument or sing in key.

In order to improve our memory, we need consciously to engage both hemispheres of the brain at all stages of memorization and retrieval: when we take in new information; when we store it in our brain (thus creating a memory); and when we attempt the processes of recall necessary to bring the information back into our consciousness. All of the memory techniques in this book follow the principle that both logic and creativity must be employed if a memory is to make a lasting impression upon our brain. Only then is the stage perfectly set for optimum recall.

The brain is continually active, even while we sleep. During the chemical processes that create memories, as well as those that conduct our other mental functions, the neurons of the brain spontaneously fire impulses at varying intervals, to create charges of electrical activity that fluctuate in voltage. The different frequencies of this electrical activity are known as brain waves.

Scientific investigation into the brain has determined that we produce different types of brain wave according to our various activities and thoughts. The beta rhythm is the normal rhythm of the brain when we are awake and active. The speed of the beta rhythm varies according to our levels of activity and how stressed we feel (when we are stressed we emit a fast beta rhythm). When we are awake, but resting with our eyes closed, our brain waves flow in the alpha rhythm. Sometimes we produce two or more different brain-wave rhythms at the same time. For example, when we are in deep sleep we produce a mixture of theta rhythms (which are slower than alpha rhythms) and delta rhythms (the slowest of all). During dreaming, or when we are drowsy (halfway between sleeping and waking), we produce only theta rhythms.

In order to optimize our ability to memorize, retain and recall information, we need to make the most of our brain when it is highly suggestive – that is, when it is emitting theta rhythms (preferably combined with alpha rhythms). But, since we are unable to memorize as we sleep, what does this mean in a practical sense? If we can find a way to encourage our brain to emit theta and alpha brain waves during consciousness, we will put ourselves in the correct “frame of mind” for optimum memorization. To do this, all we need to do is learn to relax. For many years, I have been practising meditation, which has not only benefitted my emotional well-being, but has also enabled me to train myself to slow down my brain waves so that I can memorize effectively. One of the easiest meditation exercises is a focus on the breath – try it every day for ten minutes to get yourself used to mental relaxation. Close your eyes and draw air up through your nostrils and into your lungs, in one long slow inhalation. Breathe out through your nose: mentally focus on the air flowing out through the right nostril. Breathe in again, and on the outbreath focus on the left nostril. Alternate your focus during the exercise. When you come to memorize, try to recreate and tap into the calm (the theta waves) you experience during meditation.

We use our memory constantly – each new thought or experience triggers a host of existing memory traces in the brain, whether or not we are consciously aware of them. Once awakened, they interact with the new stimulus, interpreting it, classifying it and often altering it – however subtly – to fit with what they “know” to be true. The sight of a red-capped fungus in the woods might conjure up the flavour of wild mushrooms, along with childhood warnings about the dangers of eating them. We may even hear the voice of the parent who delivered the warning. At the same time, there will be a mass of other, fleeting, memories. Part of the brain might even register the mushroom shape and evoke images of atomic explosions. Part will respond to the redness, recalling blood and danger signs. Most of these memories will be so momentary that we will not notice them, but many of them will play a part in governing our actions.

Since the nineteenth century scientists have speculated that the rich variety of our memories could be broken down into separate categories, and that each one might exist in a different region of the brain. Although their attempts to find these regions have had limited success, a few of their classifications have survived. The most important of them distinguishes between sensory memory, short-term memory (STM) and long-term memory (LTM).

Sensory memory has the shortest duration. The raw information gathered by our senses – sight, hearing, taste, smell and touch – flows into a sensory store, which is distributed between different regions of the brain. Each sense has its own associated region, which is responsible for processing its input. For example, visual information is dealt with toward the rear of the cortex, while the primary hearing centre is in the temporal lobe (a part of the cortex at the side of the brain). There are also so-called association areas in the brain, linking the sensory regions and allowing all the different inputs to be pulled together into a coherent whole.

The amount of information that can be held by the sensory store is practically unlimited, although the sensory data generally lasts for only a fraction of a second before it is replaced by new stimuli. An image in the visual cortex – called an icon – lasts long enough for a modern movie projected at 24 frames per second, to seem continuous (the image of each frame is still in the mind when the next is projected). But a silent movie, projected at its original speed of 18 frames per second, appears to flicker because the icon of each frame has already begun to fade before the next appears. Auditory information seems to last longer than data from the other senses, lingering for several seconds before it fades from our sensory memory.

The sensory store filters the signals from the senses and monitors them at an unconscious level. The vast majority of sensory information is almost immediately discarded, but a tiny percentage is selected by the monitoring procedure because it meets certain criteria – for example, an image may be intensely coloured, or fast-moving, or an overheard sentence may contain a familiar name – and is passed on to the short-term memory. This is not a simple one-step process. To the sensory memory, an apple is nothing more than a red or green, shiny, round solid. For us to perceive an apple, this information must first go to the long-term memory – also known as the permanent or reference memory – to be compared with the elements already there, in an effort to recognize what it is that we are seeing. Only after some sort of approximate match is found can the brain create a short-term memory. The whole complicated sequence is almost instantaneous.

Short-term memory is also known as the active or working memory, because it depends on the



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