'For optimists and pessimists alike, this fascinating book is a must read' MICHAEL J. FOX

Rainy Brain,

THE NEW SCIENCE OF OPTIMISM AND PESSIMISM

Sunny Brain

Elaine Fox

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About the Book

There are two basic types of personalities: ‘sunny’ or ‘rainy,’ those that see the glass as half-full or as half-empty. The tendency to see the world optimistically or pessimistically is hardwired into the brain, and reflects primal inclinations to seek pleasure or avoid danger. When our ‘fear brain’ is too strong, debilitating shyness, depression and anxiety can result. But stunning new research indicates that a range of techniques – from traditional cognitive behavioral therapy to groundbreaking visual-conditioning exercises – can alter our brains’ circuitry, allowing lifelong pessimists to think positively and find happiness.

In *Rainy Brain, Sunny Brain*, pioneering psychologist and neuroscientist Elaine Fox explores the little-understood connection between optimism and happiness, showing how we can brighten our lives – and help ourselves flourish – by retraining our brains. With keen insights into the genetic, neurological, and experiential factors that make us who we are, *Rainy Brain, Sunny Brain* offers a powerful and uplifting tool for improving our lives.

About the Author

Elaine Fox, born in Dublin, is a leading experimental psychologist and neuroscientist. Formerly Head of the Department of Psychology and Centre for Brain Science at The University of Essex, she is currently a Visiting Research Professor in the Department of Experimental Psychology at the University of Oxford. She has published widely in scientific journals and her work has been discussed in *The Economist*, *New Scientist*, *New York Times*, *Guardian*, *The Times* and others.

RAINY BRAIN, SUNNY BRAIN

The New Science of Optimism and Pessimism

ELAINE FOX

WILLIAM HEINEMANN: LONDON

At every single moment of one's life one is what one is going to be no less than what one has been.

– Oscar Wilde, *De Profundis*

A pessimist sees the difficulty in every opportunity. An optimist sees the opportunity in every difficulty.

– Winston Churchill

INTRODUCTION

ALVY'S PSYCHIATRIST

How often do you sleep together?

ALVY

Hardly ever. Maybe three times a week.

ANNIE'S PSYCHIATRIST

Do you have sex often?

ANNIE

Constantly! I'd say three times a week.

– Annie Hall

PSYCHOLOGICAL SCIENCE HAS established a simple truth: how we view the world and how we interact with it change how the world responds to us. It's a compelling fact that's all too easily forgotten. Our way of being, our take on things, the attitude we bring to life, what I call our affective mindset, colours our world, affecting our health, our wealth, and our general well-being. Psychologists have developed several ways to measure different mindsets – pessimism and optimism – so that it's now possible to quantify the differences between these fundamental ways of thinking. Most remarkably, these differences – whether we turn towards the bright side of life or the dark – can be traced to specific patterns of activity in the brain itself.

Bundles of nerve fibres connecting contemporary areas of our ‘thinking’ brain with ancient regions that control our most primeval emotions make up different aspects of our affective mind. The ‘rainy’ brain part highlights the negative, while our ‘sunny’ brain draws us towards the good things in life. Both are essential, and it’s the checks and balances between these two systems that ultimately make you you and me me. It’s our affective mind that gives meaning to our lives by tuning us in to what really matters.

For over twenty years, the diverse ways in which people interpret the world around them have been at the heart of my scientific work. My quest has been to try to illuminate, piece by tantalising piece, those parts of our brain that allow us to experience joys and fears, appreciate beauty, have fun, and worry to the point of existential despair. Affect infuses our mind with meaning, making us aware of what might harm us, alerting us to what might go wrong, drawing us towards what’s good for us, and highlighting the pleasures and sheer joys of living. Across millions of years of evolution, ancient neural structures have reached out to forge links with more recent brain regions, developing circuits and networks that tune us in to what’s important. Subtle differences in the reactivity of these affective brain circuits result in deeply divergent attitudes and outlooks on life – the heart of what I call our ‘affective mind.’ It is here that we will surely find the answers to why we differ so much from one another.

Our affective mind gives us soul, puts the fire into life. This capacity to experience and feel emotions, especially in how we react to pleasures and dangers, is shared with many other species, but when linked up with our enlarged cerebral cortex – that part of our brain that gives us our unique cognitive talents to speak, think, and solve problems – our affective mind allows us to transcend the rest of biology. This glorious intersection of thinking and feeling can lead us to be stopped in our tracks by the

haunting beauty of a sunset or to be moved to tears by a simple sequence of musical notes or words.

The same combination of ancient and contemporary brain regions also has a downside, however, leaving us vulnerable to existential angst. All too easily, we can be overwhelmed by fears and worries and laid low by the sheer ‘monstrous crying of the wind,’ as W. B. Yeats so beautifully put it.

My own attempts to understand the affective mind in all its complexity has followed the path of psychological science itself, initially focusing on the negative before turning to the question of why some people flourish, seemingly resilient to all that life throws at them. For most of its history, psychology has been concerned with problems: anxiety, depression, addictions, compulsions have all been central topics. Over the years, thousands of research grants have been won and scientific papers written on why some people are prone to a pervasive pessimism that can slide into depression and anxiety, and armies of researchers have tried to figure out effective ways to alleviate the distress caused by all this negativity. A focus on the negative is understandable and appropriate, of course, given the devastation that anxiety disorders and severe depression can cause in people’s lives.

My own approach to unravelling this mystery has been to probe the minds of the anxious and depressed with the traditional tools of cognitive psychology. Flashing positive and negative images on a computer screen, sometimes so fast that they are below the radar of consciousness, and then asking people to detect items that occur in the same location as quickly as they can, allows me to measure how quickly people react to different types of images – negative or positive – revealing a momentary glimpse of what captivates the unconscious mind. If your mind is drawn towards a negative scene, like the aftermath of a car crash, for instance, in preference to a happier image, then items

appearing in that location will be found faster. The difference may only be hundredths of a second, but decades of research using techniques like this reveal that the anxious brain shifts imperceptibly towards the negative.

The tide within psychological science is gradually turning to what makes us happy and optimistic. And this unfolding story is telling us that the optimistic mind is drawn inexorably towards the positive, while simultaneously delicately turning us away from the negative. The cognitive styles of those prone to pessimism and anxiety and those prone to optimism and happiness are, indeed, fundamentally different. Why? Do these deep-set biases play a *causal* role in why some people are pessimistic and anxious, while some are deeply hopeful and optimistic? In a nutshell, how and why does the affective mind differ so much among people?

Breathtaking developments in psychological science, alongside startling advances in the technology underlying neuroscience and genetics, give us an abundance of new evidence on these old questions. Most modern-day psychology departments house a variety of sophisticated brain-imaging machines that allow us to peer into the inner workings of our brains as never before. Combined with traditional methods, this new information throws fresh light on just how much our outlook on life is linked to processes taking place deep inside our brain.

The way we interpret and react to the things that happen has an incalculable impact on the kind of life we lead. Consider the following tale of two brothers I knew when I was a university student. Daniel and Joey were born a year apart in a small town in the west of Ireland in the 1960s. Their parents were reasonably affluent, with a small corner shop that both boys worked in when they were young. Both went to the local Christian Brothers' school and were actively involved in the local Gaelic Athletic

Association club. Their lives were not marked by anything spectacular; nothing too bad, or too good, ever really happened in their small town. Today, Daniel is a multimillionaire, living in the United States with a string of successful businesses to his name. Joey is a schoolteacher in Dublin, struggling to pay his mortgage.

Right from the beginning the two boys were different. Always on the lookout for opportunities, Daniel began a paper route from the family shop at the age of seven, earning a per cent of the profits; a year later he began to deliver groceries on his bike to elderly people unable to come into town. Most of his customers gave him generous tips. All through his teenage years, Daniel ran errands here and there, often persuading Joey to help out. By the time he went to university in Dublin at the age of eighteen, Daniel had accumulated enough money to put a deposit down on a flat near campus. He asked Joey if he wanted to pool their money together, but Joey was worried that he might lose his savings and put it in the bank instead. Daniel continued to come up with small business ideas. By the time Daniel was finished with his degree, he was renting the flat out, using the income to pay the mortgage on another, bigger property he was now living in, while also renting out two rooms to lodgers, one of whom was Joey.

Joey was always the better student; scholarly and conscientious, he obtained top grades on his final exams and went on to postgraduate studies. He turned down several chances to get involved in Daniel’s business ventures, his natural caution persuading him not to take the risk. This was often sensible, since many of Daniel’s projects were spectacular failures. In the long run, however, Daniel was highly successful, and Joey, while not unsuccessful, lived a very modest life.

Most of us can see reflections of both Daniel and Joey in ourselves. Sometimes we plunge straight in, throwing caution to the wind; sometimes we’re a bit more reluctant

to take a chance. There are times we face the world with an open heart and an open mind, ready to relish all that life has to offer. Other times, we approach the world with a more timid mindset, apprehensive and on the lookout for problems.

The way Joey's life turned out, and how different it was from Daniel's, shows us the impact that one's outlook has on the things that happen. In spite of similar backgrounds, similar abilities, similar genes, the way their lives unfolded was poles apart. A simple difference in attitude resulted in divergent life trajectories.

From the extremes of anxiety and depression, where people are convinced that nothing will ever turn out well, to milder apprehension, pessimists highlight the dark side of life. Problems are seen as setbacks rather than opportunities. Optimists, like Daniel, are alert to every opportunity and tend to jump in, boots and all. Good scientific evidence tells us that these differences affect how happy we are, how successful we become, and how healthy we remain.

My probing and analysing of these two dimensions of our affective mind has led to a surprising conclusion: the roots of our sunny brain are embedded deep in *pleasure*, the parts of our neural architecture that respond to rewards and the good things in life, while the roots of our rainy brain lie deep among the ancient brain structures that alert us to danger and threat – our *fear* brain. Tiny variations in how our pleasure brain and our fear brain react and how well this foment is kept under wraps by higher control centres of the brain lead to the emergence, over a lifetime, of a network of connections that make up our rainy brain and our sunny brain.

All of us have these rainy-brain and sunny-brain circuits, in more or less the same regions, but the potency of these circuits varies markedly from person to person; some react instantly to pleasure and fun, and others take longer to

warm up. Similarly, some people are highly sensitive to danger, worrying and fretting about the slightest threat, while others have a much higher threshold for fear. It is these differences, I believe, that form the bedrock of who we are.

In *Rainy Brain, Sunny Brain* we go on a tour of contemporary, cutting-edge science as well as explore the experiences of many optimists and pessimists. I will show you the staggering amount we have learned in the last couple of decades about what can strengthen and weaken the two crucial dimensions of our affective mind: our response to pleasure and to fear. We will see how science is beginning to unlock the mystery of what makes us who we are. It's not a simple story, with the answer lying somewhere among the boundaries of our genetic makeup, the constant flux of the things that happen to us, and, most importantly of all, how we learn to see and interpret those things that happen. Genes matter, yes, but the degree of influence they have is very much related to our environment. We are all born with certain genetic strengths, as well as genetic vulnerabilities, but whether these inclinations ever emerge depends crucially on the nature of the world we inhabit.

Our story will traverse disciplines as diverse as psychology, molecular genetics, and neuroscience to see how the deepest mysteries of what makes us who we are are gradually being unravelled. To understand this area of science we must delve beneath the quirks and biases of how we think and venture deep into the cells and networks in our brains and even down to sets of particular genes that we now know underlie many aspects of our personalities. This is a fascinating story of how genes and the things that happen to us interleave in complex ways with chains of influence running in both directions. What's exciting is that we now know that optimism, just like pessimism, results from an intricate dance of genetics, life experiences, and

specific biases in how each of us views and interprets the world around us. Beyond genetic vulnerabilities and strengths, it's what life throws at us that determines whether our genetic potentials are fulfilled and which brain circuits – positive or negative – are strengthened. It is this delicate ebb and flow of circuits deep in our brain that shapes the contours and valleys of our personalities. Whether we can gather ourselves together and emerge stronger from a crisis or whether we are bowled over by setbacks, ruminating endlessly on the negative, is influenced by whether our sunny or our rainy brain circuits dominate.

Knowing our vulnerabilities as well as our strengths is important and potentially useful. Being aware of what can elicit and even change these predispositions can help us protect ourselves and ultimately set us on the path to flourishing. The good news is that the brain circuits underlying our rainy brain and sunny brain are among the most plastic in the human brain. Prolonged stress or depressive episodes can result in structural changes in highly specific parts of our brain, just as prolonged periods of joy and happiness can transform our neural architecture. This tells us that our brains can and do change. Subtle variation in how we see the world – our biases and quirks of mind – can reshape the actual architecture of our brain, pushing us towards a more optimistic or pessimistic take on life. By changing the way our brain responds to challenges and joys, we can change the way we are.

I describe several techniques, based on strong scientific evidence, that are known to make real changes to how our affective mind operates. By modifying the checks and balances between our rainy brain and our sunny brain, we will see that we do not need to be resigned to a life of fearful avoidance, but instead we can take steps to change our outlook – and change our life.

CHAPTER 1

Rainy Brains and Sunny Brains

The Affective Mind

For there is nothing either good or bad,
but thinking makes it so.

–WILLIAM SHAKESPEARE,
Hamlet, Act 2, Scene 2

IT WAS A cold, rainy day, and I was running late. I had forgotten just how busy the tube gets during the London rush hour. Hurrying down to the platform, jostling against damp people all rushing somewhere, I heard the announcement that the Central Line was momentarily suspended. A collective groan went up. Then came the news that the Central Line was entirely shut down because of a body under a train at Bond Street station. Everyone knew what that meant: another suicide on London's ancient underground system. I'm sure I wasn't the only one who felt guilty about my irritation.

I later found out[1] that the man who threw himself under that train was Paul Castle, a wealthy property tycoon, polo player, and friend of Prince Charles. From humble beginnings, he had made and lost two fortunes and currently owned properties in some of London's most

exclusive areas, as well as a swish apartment in St. Moritz in Switzerland and a private plane to fly him there. What could have driven him to such drastic action? His friends couldn't explain it. 'It was out of character,' one said. His friend Stephen Brook said that Paul had had recent health problems and the recession had affected his business. We can only speculate that a moment of pessimism and despair had convinced him that it was not worth going on.

Late the previous night, on the other side of town, a young woman jumped off Blackfriars Bridge into the dark, freezing Thames. Apparently also intent on suicide, she panicked when she found herself in a busy boat lane and started shouting. Within seconds, Adan Abobaker, hearing her distress, grabbed and threw a life preserver as far as he could into the dark water. 'I realised it was nowhere[2] near her,' he said later. Without hesitation, he stripped off his coat and sweater and jumped in. It took Adan more than two minutes to reach the young woman, but he managed to bring her back near shore away from the shipping lanes, where they were both rescued by the crew of a safety vessel who had seen what had happened. Both survived, following several hours of treatment for hypothermia at a nearby hospital.

Adan had recently fallen on hard times and was living in St. Mungo's hostel for homeless people. 'I just did what needed to be done,' he said, making light of his bravery. 'I just hope she's got a family. Life is worth living; it's not worth giving up.' If only Paul Castle had thought that.

Some people have an unshakeable belief that things will work out. Others can only imagine a future without hope. Wealth seems to have little to do with it. Adan Abobaker had nothing and yet risked his life because 'it's not worth giving up.' Paul Castle had wealth and success beyond what most people dream of, and yet he thought it was not worth going on.

Psychologists and neuroscientists have worked long and hard to devise ways to quantify such profoundly different takes on life. A first step is to ask what we mean by the terms *optimism* and *pessimism*. Loose vocabulary, while fine in everyday life, is not concise enough for a thorough, scientific analysis. To effectively quantify these mindsets, we need better definitions of the common words used to label them.

An important starting point is the distinction psychologists make between dispositions, or traits, and states, or momentary feelings. Think of some moments of happiness or despair you have experienced, such as when you won a prize or were offered an exciting job, or when somebody died. These experiences are *states* of happiness or sadness; they reflect the transient highs and lows of everyday life. A *trait*, on the other hand, is a more stable characteristic that endures across time. These are the emotional styles or ways of thinking that remain fairly steadfast across our lives. Mary has 'Mary-like' characteristics that remain fairly stable, just as Dave stays 'Dave-like' through thick and thin. Bubbly, happy babies tend to become adventurous, outgoing children who tend to become extroverted, sociable adults.

Scientific studies support this notion. In one study, the best predictor of happiness and optimism at the end of a nine-year period was happiness and optimism at the beginning of the study. In spite of major changes in life circumstances, optimists tended to stay optimistic, and pessimists tended to stay pessimistic.

The influence that our personalities[3] have on our environmental experiences is illustrated in a study published in 1989 by Bruce Headey and Alexander Wearing of the University of Melbourne in Australia. They interviewed residents of the state of Victoria on several occasions over many years to see how life events and personality affected people's happiness. They wanted to

know the extent to which a person's personality versus the things that happened to them affected well-being and happiness. Personality might account for, say, 40 per cent of happiness, whereas life events might account for 60 per cent. Alternatively, perhaps personality would turn out to be more important.

It didn't take the researchers long to realise that they had made a fundamental mistake. As their study progressed, it was clear that the same kind of things kept happening to the same people over and over again. Lucky people were lucky again and again. Likewise, people with lots of bad experiences, like relationship breakups and job losses, seemed to encounter one bad thing after another. Their assumption that personality and life events would have separate influences on happiness was wrong. Instead, personality itself had the strongest influence on what happened to people. The optimists had more positive experiences, while the pessimists had more negative experiences.

Subsequent studies have confirmed that our personality, or our affective mindset, has a profound impact on the life events that we experience, and this does not tend to change too much over time. Picture a bubbly, outgoing child who is warm and friendly. People are much more likely to respond to this child with smiles and physical affection than they are to a withdrawn, unsmiling child. If he behaves consistently, the social world of the happy child will inevitably be more positive than that of the frightened child. There's no luck involved: the emotional style of the child is playing a part in the kind of social world she inhabits. How we act in the world changes the kind of environment we experience and hence the range of opportunities and problems likely to come our way.

Optimism and pessimism, then, just like other features of our personality, can be thought of as traits or dispositions as well as states. Dispositional optimists are

often upbeat and happy, with sunny dispositions that can infect those around them. Dispositional optimism is not just about being happy and upbeat, however; it's more about having genuine hope for the future, a belief that things will work out, and an unshakeable faith that we can deal with whatever life throws at us. Optimists are not naïve – they don't believe that nothing will ever go wrong – but they do have a deep-seated conviction that they can cope. Similarly, dispositional pessimism is not about being constantly sad and anxious but about being apprehensive about the future, aware of potential dangers, more alert to what might go wrong rather than what might go right. These are the people who err on the side of caution. Rather than take a risk, they will play it safe, although even the most pessimistic among us are likely to have times of great joy and happiness and hope for the future.

The scientific evidence that these fundamentally different mindsets come with costs and benefits is now overwhelming. One of the most important findings to emerge from the scientific literature, however, is that the real benefits of optimism only come when an optimistic mindset is linked with a healthy dose of realism. Blind optimism, and a belief that nothing will ever go wrong, is unlikely to be of any real benefit.

I discussed this with Michael J. Fox, the actor who was diagnosed with Parkinson's disease at the age of twenty-nine and is, by his own admission, an irrepressible optimist. The escalating movement problems caused by Parkinson's forced him to leave his highly successful movie and television career behind. Eighteen years after diagnosis, he was making a documentary with the unlikely title[4] *Michael J. Fox: The Adventures of an Incurable Optimist*. I was involved because Michael was interested in the scientific take on where optimism comes from and whether it can be measured in a reliable way.

Chatting after filming was complete, I saw that Michael fulfilled all the key characteristics of a dispositional optimist. An illness that would get most of us down had, it seemed, left him still upbeat, enjoying life. ‘Don’t think that I’m not aware of risk or what might go wrong,’ he told me. ‘I’m actually very good at assessing risk, but I know that I will be able to deal with whatever happens. Over the years, I have learned that I can deal with any difficulty. I don’t necessarily like it, but I generally feel I can deal with it.’

He explained that one of the most difficult things for him in the early days was the shift from people seeing him as ‘Michael J. Fox, the actor’ to ‘Michael J. Fox, the actor with Parkinson’s’ to finally ‘Michael J. Fox, the guy with Parkinson’s.’ ‘It really was tough,’ he said, but he had often wondered why he did not get depressed.

This was a real puzzle to him, as he wasn’t in any doubt from an early stage that Parkinson’s would end his flourishing acting career. Yet, apart from a couple of bouts of understandable frustration, he had always managed to stay hopeful about the future. It’s this type of resilience, an optimism that doesn’t put its head in the sand, that science has shown makes a real difference to our lives.

This type of optimism seems to occur naturally and is found in the most unlikely of places. When I was a teenager, I remember being profoundly shaken by the power of Italian author Primo Levi’s *If This Is a Man*, recounting his experiences as a young chemist from Turin in a German concentration camp during the Second World War. In pared-down, unsentimental language, Levi chronicles the horrific story[5] of a year at Auschwitz. The horrors of that year were to become the defining moment of his life. However, Levi never seemed to lose sight of the resilience of the human spirit, in spite of all the evidence to the contrary. In many ways, his book rendered one of human history’s darkest hours into a force for good in the world.

Levi attributed his survival largely to his capacity to perceive his fellow inmates, as well as himself, as people and not as objects. Holding on to this perspective allowed him to avoid the demoralisation, or what he called the 'spiritual shipwreck', that engulfed so many others.

In a later book, Levi describes his long trek to freedom marching across eastern Europe and Russia, where the 'vigorous people full of the love of life' rekindled in him the joy of living that the camps had almost extinguished. Levi's account gradually unfolds as a story of hope, echoing the experiences of many who have come through great adversity. Sometimes this optimism stems from a belief in a higher being – God – with the anticipation of a better life elsewhere; sometimes it comes from a deep-set belief in the innate goodness of humankind.

The original meaning of *optimism*[6] is much closer to this notion than to the 'rose-tinted glasses' or 'sunny-side-up' ideas that we currently associate with optimism. The original sense comes from the Latin word *optimum*, meaning 'the best possible,' and the word was first coined by the German philosopher and mathematician Gottfried Wilhelm Leibniz (1646–1716). Leibniz argued that God had created the best possible world and that this optimum world could not be improved upon. In other words, optimism had little to do with notions of 'the bright side' or the 'glass half full'; instead, it referred to the idea that the world was already the best possible and couldn't get any better.

Optimism, then, has a lot to do with accepting the world as it is – both good and bad have their place – and the trick is not to allow notions of evil and negativity to overwhelm us. Primo Levi and Michael J. Fox are realists who are fully aware that there will be problems and setbacks and that they need to be flexible and creative in finding solutions to their problems, but overall they have an unshakeable belief that things will work out in the end. And things invariably

do, not because of random luck, but because optimists take control of their own destiny. These are the people who take steps to solve their problems.

The trait of pessimism is almost the polar opposite. The mind of the dispositional pessimist becomes infused with negativity, and every setback is taken as further evidence that the world is against them. Derived from the Latin word *pessimus*, the philosophical perspective of pessimism views this world as the worst of all possible worlds and assumes that everything ultimately gravitates towards evil. In psychological science, however, pessimism, just like optimism, is viewed more as a dispositional trait or an emotional style – our typical way of dealing with the world. Pessimists are convinced that their problems are beyond their control and will never go away. 'Bad things just happen, and you can't do anything about it; you just have no control over it,' as one pessimist I interviewed told me. Believing that good things happen to other people is a hallmark of this mindset. Such feelings of powerlessness frequently lead to an enduring passivity and lack of motivation, which are other key components of pessimism and its darker cousin, depression.

Optimists, in contrast, feel that they have some control over what happens to them, tackling problems as temporary hitches rather than as ongoing difficulties. They have a natural tendency to accept the world as it is but believe that the way you deal with things determines who you are. If Primo Levi had taken the construction of the concentration camps *personally*, his experiences would have overwhelmed him. Instead, he managed to distance his thoughts by keeping in mind the humanity and decency of most of the people around him. Likewise, there was no descent into despair for Michael J. Fox when he was diagnosed with Parkinson's disease. Instead, he came out fighting and set up a foundation that is now raising millions of dollars each year for research into the disease.

Optimism and pessimism reverberate throughout our lives, leading to very different life experiences. Psychologists have come up with several ingenious ways to estimate the core characteristics of these mindsets. One option is to simply ask people, Are you an optimist or a pessimist? Psychology departments around the world are sinking under the weight of scales and questionnaires that probe and assess every attribute you can think of. Are you clever? Are you happy? Are you tough-minded? If it differs between people, there's sure to be a questionnaire to measure it.

Several well-established scales are available that tell us how we rate compared to other people. One of the simplest and most reliable is called the Life Orientation Task (LOT), developed by Charles Carver at the University of Miami and Michael Scheier at Carnegie Mellon University.

A revised version called the LOT-R[7] is presented below. Self-report measures like the LOT-R have been a mainstay of psychology for many years and are at the heart of telling us how we feel relative to others. Fill it out now to find out how optimistic or pessimistic you are. It's important to fill out each question honestly; try not to let your answers to each question be influenced by those that came before. There are no correct or incorrect answers. The important thing is to answer each question according to how you really feel and not by what you think other people might say. Once you have completed the questionnaire, you can turn to the notes at the back of the book to see how to work out your score.

The Life Orientation Task–Revised

	Agree a lot (A)	Agree a little (B)	Neither agree nor disagree (C)	Disagree (D)	Disagree a lot (E)
1. In uncertain times, I usually expect the best.	☐	☐	☐	☐	☐
2. It's easy for me to relax.	☐	☐	☐	☐	☐
3. If something can go wrong for me, it will.	☐	☐	☐	☐	☐
4. I am always optimistic about my future.	☐	☐	☐	☐	☐
5. I enjoy my friends a lot.	☐	☐	☐	☐	☐
6. It's important to me to keep busy.	☐	☐	☐	☐	☐
7. I hardly ever expect things to go my way.	☐	☐	☐	☐	☐
8. I don't get upset too easily.	☐	☐	☐	☐	☐
9. I rarely count on good things happening to me.	☐	☐	☐	☐	☐
10. Overall, I expect more good things to happen to me than bad.	☐	☐	☐	☐	☐

If you are like most people, you will have scored around 15, which is mildly optimistic. Very low scores reflect a pessimistic outlook, whereas scores moving up towards 20 and above reflect a highly positive outlook on life. The LOT-R gives psychologists a quantifiable indication of a person's core outlook on life. Our take on life will change to some extent from time to time, of course, but deep down there is a consistency to these characteristics over time. In other words, if you fill out this questionnaire again in a year's time, your score is likely to be similar.

A sole reliance on what people tell us, however, is fraught with difficulties. The problem is that many things affect how we respond: if you're attracted to the cute psychologist scoring your questionnaire, you might present yourself in a more positive way than you actually feel.

Other times people may simply lie. Most difficult of all are the times when we don't have an intimate knowledge of our own mental processes. This, in fact, is most of the time. Research tells us that we are completely unaware of the vagaries of our mental processing. If I ask you whether you generally notice positive rather than negative information in the news, you almost certainly won't know. You may think you're fairly positive, but studies that measure what type of information our brain zones in on show that these natural tendencies operate well below the radar of consciousness. Therefore, to thoroughly quantify the distinctions between optimism and pessimism, it's essential to move beyond asking people about their outlook on life.

One approach is to capture the complex patterns of how our brain reacts to the good and the bad, or how enigmatic cognitive processes can draw attention to either the negative or the positive side of life, providing us with vital information about the roots of our affective mindset. Startling developments in brain-imaging technology allow us to dig below what we say and measure the brain circuits underpinning optimistic or pessimistic outlooks in great detail.

Some of the most exciting new insights come from studies using functional magnetic resonance imagery (fMRI). This brain-scanning machine is essentially a large magnet that provides a visual image of the flow of blood around the brain. When people are thinking positive thoughts or looking at pleasant pictures, we can see which brain regions become more active as they become engorged with blood. When a part of the brain is needed for a particular task, it sparks into life and uses up lots of energy. The consequent depletion of energy sends out a signal to the rest of the brain to dispatch more oxygen as quickly as possible. Oxygen is then rapidly transported to the needy area via the bloodstream, and it's this extra oxygen in the blood that's detected by the fMRI machine.

The flow of oxygen around the nooks and crannies of our brain uncovers previously hidden processes to give us a covert view of the brain in action, and the fMRI allows us to pinpoint the specific regions of the brain linked with optimistic or pessimistic mindsets. It turns out that these patterns of brain activity are also relatively enduring. If I measure which part of your brain is active when you win a prize, the same brain circuit will light up if measured again six months later, when something else good happens. Another region may light up when you hear bad news, and this same region will again respond to disappointment in a year's time. Just as with responses to questionnaires like the LOT-R, the way our brain responds to positive and negative events measures an enduring aspect of our affective mind. This gives us a unique insight into our typical reactions to emotional events.

A real advantage of direct measures of brain activity, like fMRI, is that it's much more difficult to fake your responses or tell the researchers what you think they want to hear. This is why brain-imaging technologies are an essential part of the scientific tool-kit to uncover the source of our outlook on life. To quantify a person's level of optimism or pessimism in a more precise way, we can ask them (subjective level), or we can measure the brain circuits associated with these different mindsets (neural level).

A third way to probe the inner workings of our affective mind is to examine our way of looking at the world – our deep-rooted biases and quirks of imagination that lie at the heart of who we are. These cognitive processes lie somewhere between what people say and the spikes of activity of individual cells, or neurons, deep in our brains. Our cognitive biases – subtle shifts of mind towards the good or the bad – cannot be measured by asking people, because we are simply not aware of these subterranean mind shifts. Similarly, brain-imaging techniques cannot

fully uncover the subtleties of memory, imagination, and interpretation that emerge from neural activity.

These states of mind – our cognitive biases – are best accessed by the traditional methods of cognitive psychology. For example, imagine you are walking along the street and see an acquaintance whom you have not met for a long time. While you are ready to greet him, he walks right by without acknowledging you at all. You might assume that he's being rude, does not like you, doesn't want to talk, and has, in fact, deliberately ignored you. Alternatively, you can conclude that your acquaintance was busy and preoccupied and so simply didn't notice or recognise you. Perhaps he couldn't remember your name and didn't want to embarrass himself. Social situations like this are highly ambiguous, illustrating why our *interpretations* have such a big influence on how we feel. A more positive interpretation of events – he was preoccupied – maintains and nourishes an optimistic mindset, whereas a negative interpretation – he doesn't like me – can spiral into negative thoughts and a pessimistic mindset.

Biases in how we interpret things are at the core of our affective mind. Our brains contain a multitude of such biases, operating well below our radar of consciousness and ultimately leading us to having a particular slant on things. This tendency of our affective mind to zone in on the good or the bad, or to interpret ambiguous social situations in flattering or gloomy ways, is the basis of how we experience the world around us.

How do these slants of mind come about in the first place? A large part of the answer has to do with how we select what to focus on from the confusion of sounds and sights bombarding us at every moment. In a world containing an endless stream of information, what we notice is becoming ever more important, and this selectivity has crucial implications for our emotional stability. This aspect of mind – what cognitive psychologists

call *selective attention* – forms the kernel of our affective mind.

To see how selective attention operates, stop reading for a moment, and concentrate on what you can hear. I bet lots of things now come into focus that you didn't notice before – the hum of the central heating, a distant plane, birdsong outside, children playing in the street, a distant radio. You may also now feel the weight of the book (or e-reader) in your hands, the pressure of the chair at your back. You may suddenly remember something you need to do later. All of these sensations and thoughts were there all the time; you just weren't paying attention to them – they were in the background. This habit of our brain to bring into focus what is immediately relevant, and to screen out the rest, is vital. Without this ability we would be overwhelmed by information overload. This same selectivity, however, filters out what our brain considers to be irrelevant and therefore is the starting point in the construction of our affective mind and what it learns to highlight and to ignore.

As a cognitive psychologist, I am intrigued by this ability of our brain to focus on some things more than others, to absorb and remember specific facts and experiences, and then weave them into a coherent narrative coloured by our personality and by our life experiences. This surely has to be one of the most fascinating stories in contemporary science. We now know that each and every one of us has a mind permeated by a myriad of biases that colour how we see the world and how we remember our past. From the moment we are born, smells, sights, sounds, and textures bombard us from every direction. Capturing the essence of this internal turbulence, William James, the founder of scientific psychology in the United States, described the infant's impression and experience of the world as a 'blooming, buzzing confusion.'[8] This 'confusion' has to somehow be made sense of, and it's our brain's job to achieve this complex task. From the multitudes of things

we take note of, our brain has to somehow make sure that we notice the important things and not pay too much attention to those that are less relevant. Things that might injure us (dangers) or those that might sustain us (pleasures) are understandably the strongest magnets for this affective energy, whereas details like the colour of pictures on the wall aren't critical and can therefore be safely ignored. This is why our mind is infused by an affective energy that guides all of our mental processes.

When I was a young girl, we had an elderly neighbour named Mr Graham, whom I regularly helped out. Mr Graham must have been in his eighties, and his tall, athletic build was beginning to become fragile. He had run on the cross-country team for Trinity College in his youth, but a serious leg injury sustained in the First World War, in addition to his advancing years, had left him slow and weak. His beloved wife had died a few years before, and while he could still hobble around his treasured garden, he now found it difficult to get out to the shops. I used to do some shopping for him and occasionally made him lunch, although this fiercely independent man was reluctant to accept much help.

We lived in a beautiful area about twelve miles from Dublin City, surrounded by stunning coves, beaches, and coastal scenery. On sunny summer Sundays, the crowds of North Dublin descended on the beaches and walkways of Howth. Unfortunately, the Irish weather is rarely sunny, and for many months of the year the dark clouds, dank fog, and bitter winds that swirl in from the sea can make life challenging. But even on those darkest days, Mr Graham's optimistic outlook was remarkable. On bitter frosty mornings, he would point out to me the first signs of a new bud breaking through the hard soil. 'Won't be long before the daffodils are out,' he would say. He told me stories of the war, and although they were peppered with tragedies

and dark moments, he seemed energised by happy memories of camaraderie and deep friendships.

He was not unaware of tragedy; he was sometimes very sad and clearly felt intensely the loss of his wife of more than fifty years. But he always looked on the bright side. He seemed to notice the good things, and the bad just didn't get him down too much. I remember one cold morning waiting at the bus stop outside his house on my way to school, watching him struggle up the steep hill to the road to put out his rubbish. I knew from experience that there was no point in offering to help. He finally dragged his bin to the gate and, breathing heavily, looked out over the raging cold sea barely visible through the grey mist. 'How lucky we are to live in such a beautiful place,' he said.

Our affective mindset sets the course that our life will take. Think of the ambiguity of a half smile on your boss's face as you arrive a little late for a meeting. Is she pleased to see you, or is she annoyed that you are late? How you interpret that smile affects how you would feel about being given extra work. The positive take – *she is relieved I am here* – might make you think that this is important work and your boss has faith that you will do it well. The negative interpretation – *she is angry that I am late* – is likely to make the extra work feel like a chore or even a punishment.

A tendency to pay more attention to danger or negativity, however slight, can result in a pessimistic view of a world filled with constant dangers and disappointments. A partiality for pleasure and positivity, like Mr Graham's, can give the impression of a world overflowing with success and good things. How does our brain achieve this feat? How do our unique personalities and ways of looking at life translate into how much we notice and remember about the world? More importantly, how does the way in which we view the world influence our emotional style and outlook?