walking by and no sign of life in the barber's, then it must be a Sunday. The temperature and the presence or absence of leaves on the sycamore trees will give a clue as to the time of year, and if the sun is out, its position in the sky would give a rough indication of the time of day.

The cyclical nature of the calendar helps us to organise time in our minds. When you are at school, the academic timetable punctuates the year, a punctuation that can have a lasting emotional impact (from which some teachers never escape). The American psychiatrist John Sharp has noticed that a number of his clients feel worse at the end of the summer – a hangover from years of back-to-school dread. Surprisingly, in the temperate climates in the northern hemisphere suicide rates are higher in the spring, as though deep despair sets in when the promise of spring fails to deliver respite from a spell of misery.

As you'd expect, the effect of the seasons varies depending on where you live, as do attitudes towards time. To investigate this the social psychologist Robert Levine compared the tempo of life in 31 countries around the world using three indicators. First, he measured the average walking speed of random pedestrians walking alone in the morning rush hour along a flat street with wide pavements. How fast did people choose to walk? Window-shoppers were excluded on the basis that they dawdle, and the streets selected were not so congested that the crowds would slow people down. Second, he wanted to compare the efficiency of an everyday task, so he measured the time taken to request a stamp in the local language, to pay for it and to receive the change. Finally, to establish the value placed on time-keeping in each

culture, the accuracy of 15 clocks on the walls of banks in each city was checked. Combining these measures gave him an overall score for pace of life. It may not surprise you to learn that the USA, northern Europe and South East Asian countries had the fastest tempos, but Levine's findings weren't all so predictable. The efficiency of stamp-selling in Costa Rica brought the country up to thirteenth place in the tempo charts (funnily enough that's the exact opposite of the experience I had buying a stamp there, but then that's why we have systematic research on these things, rather than relying on anecdote). Even within the same country the variation can be extreme. On comparing 36 cities in the USA, in this instance combining walking speeds and clock accuracy with the time taken to obtain change in a bank, Boston came out fastest, while the home of showbiz, Los Angeles, was slowest, let down by particularly laid-back bank clerks. Everyone expected New York to come out on top, but in a 90-minute observation period during the early 1990s, the researcher witnessed one pedestrian dealing with a mugger and another with a pickpocket, which might have slowed them down.

At the time of the study the countries with the fastest tempos were also the countries with the strongest economies. This raises the question of which comes first – do people in active economies move faster because time is perceived to be more valuable, or did the fast pace of life lead to economic success? There's no doubt that energy and speed can help some businesses, but in some cases there is a limit to the extent to which the speed of your work can increase the market for your goods. However fast you make umbrellas,

if it never rains where you live, no one will buy them. So the relationship between tempo and gross domestic product is best seen as a two-way interaction. Speed leads to some economic success, but economic success also requires people to move faster and makes a society more reliant on the clock.

## TIME'S SURPRISES

So our minds create for us an experience of time which not only feels smooth on the whole, but which we can share with others, allowing us to co-ordinate our activities. Despite this, time never stops surprising us. The reason time is so fascinating is that we never appear to become accustomed to the way it seems to play tricks on us. Throughout life, we find it warps. We comment on weeks that seem to rush by, while others drag. We fly into a time zone that is behind us and create the illusion of cheating time, of living a few hours of life twice. Fly the other way, and we wonder what happened to the time we missed. Despite the longer evenings we get when the clocks go forward in spring, there is still a nagging feeling that an hour has been stolen from us. And when the clocks go back in the autumn we feel a sense of satisfaction at gaining an extra hour which marginally lengthens the weekend. The White Night festival in Brighton on the south coast of England, and its sister event Nuit Blanche in Amiens in France, were established to explore the theme of how you might use that extra hour in the middle of the night. You can do everything from listening to music in an aquarium to learning to knit in a bar. Although our rational side is well aware that this extra hour is just a trick of the clock, we still

feel we are losing or gaining time, and this begins to illustrate how much of our relationship with time is based on illusions we create in our own minds.

In 1917 the wonderfully named researchers Boring and Boring conducted an experiment in which they woke up sleeping people and asked them to estimate the time, something the participants (including Mr and Mrs Boring themselves) were usually able to do successfully to within 15 minutes. But not everyone can do this. Although most of us find time slightly mystifying, for some of us it is utterly inscrutable. Eleanor is 17 and tells me she has never quite 'got time'. She is aware that she cannot judge its passing in the same way that everyone else seems to. When she wakes up in the morning, unlike the people in Boring and Boring's study, she has no idea what time it is and this continues all morning. She does not seem to sense time moving on. 'I don't know the time until lunch-time, when I start feeling hungry. I deliberately look for clues like that to work out how much time is passing.' At school she finds that while other people are able to make a rough guess, she can get the time wrong by several hours. Without checking the clock she has no idea whether a lesson is near the beginning or about to end. She inadvertently leaves her mother waiting where she has come to collect her because time doesn't feel as though it's passing, so she forgets to check her watch. So far the inconvenience has been mainly for her patient parents, but now that she's taking exams, she's beginning to notice the problems this lack of time perception can cause. While other students plan how much time to spend on each

question, unless Eleanor constantly monitors the clock she doesn't notice that it might be time to move on. Her case illustrates that we don't all share the exactly the same concept of time. Eleanor also has dyslexia and this could hold the key to her difficulties with time perception. There is an intriguing link between the two, one which I'll return to when I discuss how the brain measures time.

For Eleanor time is constantly surprising, but in some circumstances it can be just as unnerving for the rest of us. We marvel, somewhat anxiously, at where the weekend went and how fast other people's children seem to grow up, or despair at how time drags in an airport queue. Imagine you are watching the final five minutes of a football match, and how differently that time passes depending on whether your team is winning or losing. If they're 1–0 down five minutes simply isn't long enough. If they're 1–0 up, time appears to stretch, giving the other team far more chances to level the score than they deserve. Think of a journey and how the way back always seems shorter. With fewer new memories to fill the time, everything seems familiar and it feels as though the distance is much shorter, unless, as the nineteenth-century philosopher and psychologist William James observed, you are retracing your steps because you have lost something. Then it seems endless. Time plays tricks on our minds.

As young children grow up, these mysteries of time are something they begin to observe for themselves. I asked two brothers what they had noticed about time passing. 'When you have to brush your teeth for two minutes that seems like a long time, but when you're watching TV two minutes

goes really fast,' said eight-year-old Ethan. His 10-year-old brother Jake observed, 'If you're waiting for someone in the car while they go shopping it seems longer than if you do the shopping yourself.' These children have already noticed that time is deeply subjective. Our sense of time passing can even depend on the way we feel about our physical well-being. The psychologist John Bargh gave people anagrams to solve, then noted the time it took them to walk to the lift to go home after the experiment. Half the people were given anagrams of everyday words, but half were given words that might be associated with older people, such as 'grey' and 'bingo'. When these people walked to the lift, these subtle hints about old age had primed them to such a degree that it changed their sense of timing and they walked more slowly.[7]

So what are the major factors that cause time to warp? The first is emotion. An hour at the dentist feels very different from an hour working up to a deadline. If we look at pictures of serene faces we are quite good at guessing how long we watched them for, but show us a series of frightened faces and we overestimate the time that passed. However, the best illustration of the power of emotion to skew our perception of time is more dramatic – the slowing down of time when you are fighting for survival; when, like Chuck Berry falling through the sky, you are genuinely in fear for your life, one minute becomes elastic and can feel like fifteen.

## TIME SLOWS DOWN WHEN YOU'RE AFRAID

Alan Johnston had long known that kidnapping was a risk that came with the job of a foreign journalist in

Gaza. It was an eventuality he had rehearsed in his mind before it happened in real life. When that fated day came around, and he saw a man get out of a car holding a pistol, his initial thought was, 'So this is how being kidnapped feels and this time I'm not just imagining it.' Then for a while everything went into slow motion. 'You can almost stand back and watch yourself going through it,' he told me.

Several weeks after he was captured, his captors gave him a radio. One night he heard a story on a BBC World Service news bulletin that made time slow down once more. 'They said that I'd been killed.' He began to think that perhaps the kidnappers' public relations department had got ahead of itself and released the news too early. Was this what they were planning to do tonight? 'It seemed more likely that they would want to keep me alive because that would be more useful to them, but when you're lying in the dark hearing that message going out to the world and they say they've killed you, there's a part of you that wonders if they're going to do it. Maybe tonight's the night.' For Alan, this felt like the longest night of his four months in captivity. Time definitely slowed down.

When people are afraid they might die, whether in a situation like Alan's, in a plummeting glider like Chuck Berry's, or in a car accident, they often report that the event lasted far longer than was possible. Somehow in just a few seconds they find the time to consider a great number of topics in detail. They think through their past, they speculate on the future and all the while they scan their

memories for any piece of knowledge from anywhere which might help them to survive. This experience of time deceleration through fear is well-established, and – provided you feel frightened – time can distort even in a non-life-threatening situation. When people with spider phobias were instructed to look at spiders for 45 seconds (I am amazed they ever agreed to take part in this experiment), they overestimated the time that had passed. The same happened with novice skydivers. If they were watching other people, they gauged the duration of the fall to be short, but once it was their turn, time seemed to move more slowly and they overestimated the minutes they spent in the sky.

## THROWING PEOPLE OFF BUILDINGS

Is this deceleration of time simply an illusion, or does the way we process time actually slow down when we are in fear for our lives? If the brain does process time differently when we are terrified, then it should also be able to process sights that are usually too rapid to see with the naked eye. To discover whether this is true, all you need to do is to scare people out their wits and then give them a test during that terror. One man knew just how to do it, and – in what appears to be something of a theme in research on time perception – was prepared, along with his brave volunteers, to go to extraordinary lengths to achieve it.

On the day of the study it was particularly windy. This was perfect. For the 23 volunteers standing on top of a Texas skyscraper, the wind injected a little extra anxiety into

an already fraught situation. If this experiment was to work, real fear was essential. The neuroscientist David Eagleman, from Baylor College of Medicine in Houston (the same neuroscientist who wrote the best-selling imagined stories of the afterlife, *Sum*), warned his volunteers to stay well back from the edge until it was their turn to climb up inside a 33-foot-high metal cage mounted on the roof. He radioed down to the team on the ground 150 feet below to check that everything was ready, then turned to a line of digital wristwatches with giant faces. These perceptual chronometers were set to alternate very quickly between two screens showing random numbers. They flicked so fast that to the naked eye they looked like a blur. Eagleman wanted to know whether terror would speed up a volunteer's sensory processing enough for them to read the numbers which the calm human brain fails to register. Perhaps it's not that time slows down when we're afraid, but that our minds speed up.

Eagleman had previously experimented with taking the volunteers on a rollercoaster, but they just weren't scared enough; and in fact many seemed to enjoy the experience. It was time for something more drastic – freefall. Eagleman knew that no one would agree to take part in this experiment unless he had shown that he was willing to do it himself. Strapped into a harness, he was dangled over the side of the tower block and dropped, backwards. (Forwards wasn't sufficiently frightening.)Then he did it again. And then again. Before the third attempt he was convinced that he would be less terrified; experience would surely tell his brain that he would be fine. But no, he told me, 'It was still

beyond scary.' Then it was the turn of a young man called Jesse Kallus. Just as Eagleman had been before him, Jesse was thrown off the building and by the time he had been caught safely at the bottom he had reached a top speed of 70 miles an hour.

Everyone who took part in the experiment reported that time felt as though it decelerated. The fall stretched every one of those unbearably petrifying seconds. So the first element of the study had worked; the desired effect of subjective time dilation had been achieved. Yet still the figures on the watch face flickered too fast for their brains to perceive them. David Eagleman had demonstrated that time itself doesn't actually slow down when we're afraid, and nor does the brain's sensory processing speed up. What changes is our perception of time – our mind time.

So how does this happen? It is true that fright does etch strong memories into the brain, and – as will emerge in this book – memory is one of the key factors in making time warp. When people are shown a video of a bank robbery lasting exactly 30 seconds, two days later they tend to guess that it lasted five times longer than it did. The more disturbing a version of the video they are shown, the greater their overestimation of its duration.[8] After a stressful event we often recall every single detail of what we saw, heard or even smelt. The richness and freshness of these memories contributes to our sense of how long it lasted. We become accustomed to a certain quantity of memories fitting into a certain time-frame. Usually this serves us well, but during a life-threatening incident the intensity of the experience results in the creation of more memories. Every

second feels brand new, which causes us to judge the event to have taken longer than it really did, to have happened in slow-motion. This sensation is amplified by the fact that in a car accident, for example, the mind focuses on the elements of a situation necessary for survival and filters out anything inessential such as the scenery, the songs changing on the radio or the number of cars that pass. These are the cues which would normally help to assess time passing. Without them, once again time warps.

The big question is whether the combination of the plethora of memories and the absence of cues to time passing is enough to make time decelerate this drastically? There is a more radical explanation – is it possible that the way the brain actually measures time could make it feel as though it slows down? If the brain counts time by monitoring its own processes, when it moves extra fast in an emergency this could cause it to count more beats and to believe that more time has passed. So while the brain is racing to save itself, so is its clock. I'll come back to this in the next chapter. Before that there are other curious factors that distort time. The life-threatening, mind-racing moments of intense concentration are not the only occasions when time decelerates. The opposite – having *nothing* on which to fix your mind – in other words sheer boredom – has a similar, though less extreme effect, as do a series of other experiences.

## NOT THE KINDEST OF EXPERIMENTS

You arrive to take part in a study. You know it is to take place in the psychology department, but not what it involves.

There are five other participants, all wearing name-tags. Everyone seems friendly, if a little unsure of what might be about to happen. The woman in charge says that first you should get to know each other and she gives you a list of topics to discuss, among them the place you would most like to visit in the world, your most embarrassing experience and what you would choose if you could have one magic wish. Soon you're happily exchanging tales of humiliating incidents, like the time you got an electric hot-brush stuck in your hair on the way to a wedding and had to walk along the street with the flex hanging down from your head (this happened to me). The psychologist says you will be working in pairs and, to make things go smoothly, you should write down the names of the two people from the group with whom you would prefer to work. That's easy. You hand in your form and wait to see who you'll be paired with. But when they call you in for your turn they look rather embarrassed and say that no one has put you down as someone they'd like to work with. They say that in all the studies they've been running, this is so unusual that they think it best for you to work on the tasks alone. You're a bit surprised, and – if you're honest – hurt, but you try to tell yourself that it doesn't really matter what a group of strangers thinks of you and that you didn't particularly like them anyway. You're determined not to show anyone that you're upset and to do the tasks as well as you can. For the first task, they start a stopwatch, then stop it and ask you to guess how much time has passed.

While you sit alone wondering why no one likes you, what you don't realise is that every other member of the

group has also been taken aside to separate rooms to work alone, but while half were given the same explanation they gave you, others were told they must work on they own because they had been chosen by everyone, making it difficult to allocate partners fairly. A harsh experiment you might think, although not as bad as a study later in the same series where they tell you that the results of your personality questionnaire indicate that although you might marry several times, none of your relationships will last and you are likely to spend your old age alone. I should add at this point that after all experiments like this participants are debriefed and told it's all a fiction.

The intriguing result of this rejection study is that the belief that a few strangers dislike you can alter your time perception. The people who were told they were popular estimated the 40 second test as lasting an average of 42.5 seconds, while the rejected group came out with an average of 63.6 seconds.[9] Although 20 seconds might not sound like much, the fact that there was a difference is quite extraordinary. The rejection had made them painfully aware of everything happening in the present. Their misery had stretched time.

This research on rejection and time perception stemmed from the work of psychologist Roy Baumeister, who studied people who were contemplating suicide. Those in this situation tend to experience what is known as a deconstructed state, where they have such a strong sense of an inner numbness that they have little or no concept of a future and find it hard to imagine that life might ever improve if they remain alive or that choosing death would

have serious ramifications. People planning suicide are in a very particular mental state where the perception of time can become skewed. As an aside, it is a state which can also explain why suicide notes often reveal so little. The American sociologist Edwin Shneidman spent more than a quarter of a century studying the meaning of suicide notes after finding a collection of them in the vaults of the Los Angeles County Coroner's office in 1959. He decided to devote his career to their study, determined to gain an insight into the suicidal mind. His analysis showed, probably not surprisingly, that suicide notes contain a greater percentage of first-person singular pronouns than other sorts of documents. But it seems in terms of insight their content is disappointing. After spending more than 25 years obtaining and analysing notes, Shneidman concluded that most tell the same story, and despite being 'written at perhaps the most dramatic moment of a person's life, are surprisingly commonplace, banal, even sometimes poignantly pedestrian and dull'.[10] Later in life he decided that odd phrases could sometimes be telling, but that most notes still bring little by way of explanation to those left behind. Only a third of people who kill themselves even leave a note. Somewhat harshly Shneidman believes that those who do are the kind of people who like stating the obvious. He doesn't disguise his bitterness at his disappointment with the style of the notes: 'To a "Quarantine – Measles" sign such a person might add the words "Illness inside – please stay out".' He believes that because people who are about to kill themselves are in this altered state, a state of such fixed purpose where time is warped, they are unable to

explain much about their state of mind. The tragedy here is that an explanation is exactly what those left behind are searching for. And Shneidman believes we optimistically look for even more than that; we hope that someone on the brink of death might have some 'special message for the rest of us'. But lest we think that Shneidman was lacking in sympathy for those driven to suicide, he did a great deal to pioneer the field of suicide prevention and co-founded the Los Angeles Suicide Prevention Center in 1958, a centre that was to become famous in 1962 after it concluded that Marilyn Monroe's death was caused by 'probable suicide'.

People with depression can experience distortions of time even if they are not feeling suicidal. During an episode of depression, the past and the present become central, while the future – especially any kind of hopeful future – is almost impossible to imagine. The British psychiatrist Matthew Broome has frequently seen this in patients. And experiments confirm that people with depression give time estimations that are on average twice as long as those who are not depressed. In other words time is going at half its normal speed. This leads me to wonder whether in some cases depression could be considered a disorder of time perception. Or perhaps the slowing of time is a consequence of depression, which then helps to maintain it and makes it harder to escape from. Matthew Broome points out that we know that sleep deprivation and the use of a light box can both elevate a person's mood as they confuse the internal clock.[11] When a person is depressed the present and the future become 'bound to one another in suffering'.[12] The effect is so distinct that the philosopher of psychiatry

Martin Wyllie suggests that as an additional diagnostic tool, mental health professionals could ask their clients to estimate the duration of the consultation. I wonder whether you could simply ask them to estimate the passing of a minute. If 40 seconds feel like a minute to them, then time is stretching. The more slowly time is passing for that person, the more severe their condition might be.

Time also decelerates for the most anxious cancer patients. The psychophysicist Marc Wittman has found that they overestimate time intervals and report that time seems to be slowing down. Contemplation of their mortality has directed their attention to the passage of time with the result that it protracts it.[13] In contrast, for patients experiencing conditions involving a break with reality, such as schizophrenia, time can distort in many different ways – appearing to vary in speed, repeat itself or even stop altogether. The Cotard delusion takes this distortion of time perception to extremes. Named after the French neurologist who first described it in 1882, the Cotard delusion is a rare condition of extreme pessimism, beginning with depression and ending in the denial of everything, including possession of the main organs of the body, having a family, a future or even an existence. Back in 1882 Jules Cotard wrote of one of his patients, 'Stating that she was no longer anything, the patient begged for her veins to be opened up, so that it could be seen that she had no more blood and that her organs no longer existed.'[14] In a sense this is the ultimate disorder of time. There is no sense of a past or a future, and three-quarters of the patients in the subsequent case reports of this rare condition even believed that they were

dead.[15] It is very rare, but, as we'll see, problems with the perception of time could also be a root of a far more common condition.

## HYPERACTIVE TIME

He doesn't sit still. He fidgets. He can't concentrate. He moves impatiently from one thing to the next, constantly getting distracted. This might sound like the description of any lively child. But there is a big difference. Children with attention deficit hyperactivity disorder, or ADHD, do these things far more than other children of the same age and it has been discovered very recently that faulty timing might be the key. Children with ADHD are rooted in the present. They find it hard to consider the consequences of their actions and they find waiting, even for a short time, excruciating. This might be because what feels like five minutes to the rest of us, feels like an hour to them, so when they are told to sit and wait for five minutes this could be a task they find genuinely challenging. In laboratory experiments children with ADHD find timing tasks very difficult. Their experience of time appears to be different from that of other children. If they are asked to say when three seconds have passed they think they're over in far less than that; in other words if you have ADHD time passes very slowly. This finding is so common in children with ADHD that Katya Rubia, a cognitive neuroscientist at the Institute of Psychiatry in London, has been able to use time estimation tasks to correctly classify 70 per cent of cases, quite a feat considering there are

currently no conclusive tests for ADHD; current diagnoses rely on experts watching a child's behaviour and then making a judgement.

It seems remarkable that the most common childhood disorder, affecting between 3 and 5 per cent of all children, could be down to timing. It manifests itself in various ways. If I were to ask you whether you'd like £100 now or £200 in a month's time, most of you would go for doubling your money, but for people with ADHD, delayed gratification is unappealing. If children with ADHD are asked to watch for a red light to come on, wait five seconds and then press the button in order to get a prize, they are so keen to press the button that they can't resist pressing it straight away. Children with ADHD find it very hard to wait and often act prematurely, without considering the consequences. While many of us strive to live more in the present, these children live too much in the present.

If ADHD is a disorder of time perception, could you somehow change a child's relationship with time and in turn reduce the symptoms of ADHD? At the moment therapeutic intervention tends to focus on inhibition and helping children to think before they act, but Katya Rubia plans to develop a form of cognitive behavioural therapy where children are taught how to wait and how to delay. This is something I'll come back to in Chapter Five. The difficulty is this: if a child experiences the passage of time in an unusual way, teaching them to wait won't eliminate the fundamental problem. They might learn to tolerate the aching slowness of time, but if a five-minute delay feels like

an hour, then it always will. They might be able to learn not to behave impatiently, but to them wouldn't it still feel like an agony of time? Here Katya is optimistic that the brain's plasticity is such that if she can teach them to behave differently, then this could eventually have an impact on the brain and on time perception itself. She has already demonstrated that Ritalin, the drug commonly used to treat the symptoms of ADHD, does improve time perception and the estimation of milliseconds. Perhaps learning to wait would give children the opportunity to learn to judge a time interval more accurately. As Katya told me, 'If you never wait, you probably don't learn to estimate a time interval properly.'

To sum up: so far it is clear that ADHD, extreme fear, rejection, boredom and depression can all lead to the sensation that time is slowing down. The next situation which can dilate time is altogether more surprising.

## DIVING FOR TIME

There were fourteen scuba divers in all – six amateurs and eight Royal Engineers. It was a hot August day in Famagusta Bay in Cyprus in the mid-1960s. The resort was fast becoming the place to be seen. New hotels were appearing; ready to accommodate the rich and famous on holiday. Archaeological excavations in the long arc of sand were slowly revealing a perfect oblong of pillars outlining the site where an old gymnasium stood, until, according to legend, in the fourth century BC the king burned down his Palace of Salamis rather than submit to the Egyptians.

But the 14 scuba divers were not here to admire the archaeological sites, nor even the grouper fish and Spanish lobsters under the water. They were here to take part in a study on time. At the start of the experiment, each diver sat with a thermometer in his mouth while his pulse was taken. Then, without counting, he had to guess when a minute had elapsed. Next a Royal Engineer handed him a one-ounce charge of gun cotton and lit the fuse. The diver's job was to take the fuse, swim down 15 feet to place it on one of the many shipwrecks submerged beneath the waters of Famagusta Bay and then return to the surface to wait for the explosion. Then the initial routine of sitting on the deck while his pulse and temperature were taken and estimating the passing of a minute was repeated. But here was the catch. The divers were instructed that if the charge did not explode within a few minutes they were to dive back down to the shipwreck to retrieve the gun cotton. These explosions were genuine, so not surprisingly this injected an element of anxiety into the experiment. It was conducted by Alan Baddeley, who was later to become one of Britain's most eminent researchers in the field of memory. He was in Cyprus to follow up an experiment he had conducted one March day in the cold waters off the coast of Wales. He had discovered (no surprises here) that the divers were colder after their dive, and that the colder they were, the longer they estimated one minute to be. In other words for them time felt as though it were going fast (if this sounds strange to you, remember that if time had felt slow, they would have *under*estimated the minute passing, feeling that after 40 seconds it must surely

be over). However it was possible that instead of time speeding up *after* the dive, their anxiety might have slowed time down *before* the dive and that this might be the explanation for the discrepancy in the before and after timings. So he relocated his experiment to the warm waters off Cyprus and devised a task where the divers' body temperatures would barely change, but which was extra stressful, due to the inclusion of the explosions. In the experiment in Cyprus there was hardly any difference in the speed of their counting, before and after the dive, supporting his original idea that it was temperature that was changing the perception of time in the Welsh divers, not anxiety.[16]

Three decades earlier the wife of an American psychologist called Hudson Hoagland was lying in bed with flu. Although her husband was caring for her kindly, she complained that whenever she needed him he seemed to be absent from the room for long periods. In reality he was only away from her for a few minutes at a time. Wondering whether her experience of time was askew, he took the opportunity to conduct an experiment on time perception and body temperature. Her fever was causing extreme fluctuations in her body temperature so every time the thermometer gave a new reading, he asked her to count the seconds passing until she reached one minute, all the while monitoring her accuracy with a stopwatch. And just to be on the safe side, at each temperature he persuaded her to perform the counting task five more times, meaning that in the space of 48 hours his ailing wife took part in 30 trials for the experiment.[17]

He discovered that not only was she a very patient patient, agreeing to his constant requests for her to spend a minute counting without knowing why, but that the higher her temperature, the sooner she thought a minute had passed. When her temperature reached 103 degrees, time had slowed to the extent that she thought a whole minute had passed after just 34 seconds.

Hoagland must have possessed strong powers of persuasion because for his next experiment he convinced a student to submit to diathermy – that is for his body to be wrapped up tightly and then artificially raised to 38.8 degrees using an electric current. Bearing in mind that a body temperature of 40 degrees would be considered a potentially life-threatening emergency, the student was unsurprisingly rather anxious, which Hoagland remarked rendered his initial time estimations somewhat erratic. Once the student had managed to relax, his perceptions of time were altered in the same way they were for Hoagland's wife. As his temperature rose, time decelerated. Hoagland tested just two people, but Baddeley's later work with the divers confirmed that body temperature can warp our experience of time.

## FIVE TIMES A DAY FOR 45 YEARS

The discovery of the next factor that can slow down time required great dedication, something this field of study does seem to engender. Robert B. Sothern is a biologist who has been taking a series of measurements every single day since 1967. Five times a day he estimates the passage of a minute

without looking at a clock; measures his blood pressure, body temperature and heart rate; tests his eye-hand co-ordination and rates his mood and vigour. For 19 years he even co-opted his parents to help with the task and for several decades he also recorded data on the strength of his grip and the volume of his urine. It all began after he volunteered to travel from the United States to Germany to take part in an experiment where he lived underground for three weeks without any means of keeping time. This experience gave him the idea of investigating how his rhythms changed as he aged, using that most willing of participants – himself. Where else could you find a subject so motivated and conscientious that they let neither holiday nor illness disrupt the research process? Robert has now conducted more than 72,000 measurement sessions and tells me he has no plans to stop.

Robert's main interest is in how the timing of medical treatment might affect its efficacy. Does it work better in the morning or the evening or on a particular day of the month? It's a field that he acknowledges is regarded with scepticism by the medical community and, seeing the sparsity of the evidence, it's likely to remain so. But what interests me is a sideline of this research. His decades of measurements of time-estimation reveal another factor which slows down time – youth. During his period of isolation in Germany his time estimations showed that for him time was decelerating. But as he left his twenties the opposite happened and time appeared to be gradually speeding up.[18] This is a common sensation as people get older, and one that I'll explore later in the book.

## HOW TO MAKE TIME STAND STILL

So emotions, fear, age, isolation, body temperature and rejection can all affect our perception of the speed of time, as does concentration, or 'attention' as it tends to be referred to in the psychological literature. If you happen to be in a room that has a clock with a second hand that ticks rather than sweeping round smoothly in one motion, glance up at the clock face and see what happens. If by chance you catch it at the right moment the second hand will appear stationary for longer than it should. You wonder whether the clock has stopped, only for it to start moving again a moment later. This is a demonstration of chronostasis: the illusion that time stands still. If it doesn't work the first time, glance up a few more times and eventually it will. The traditional explanation for this illusion is that in order to present us with a consistent image of the world that doesn't blur every time we shift our gaze across the room, our brains momentarily suppress our vision whenever we move our eyes. The result gives us the impression of life as a smooth film. In order to compensate for this moment of suppressed vision we assume, not unreasonably, that most objects in a room are stationary. The ticking second hand tricks our brains. Or that's the theory. The problem with this explanation is that the clock illusion occurs with other senses too. A similar phenomenon known as the dead phone illusion happens in countries where the dialling tone consists of beeps interspersed with silence. If you pick the phone up at the right moment the initial silence feels so long that you get the impression that the phone is dead.

So what does this have to do with attention and the warping of time? Well, the researcher Amelia Hunt has an alternative explanation for the clock illusion, one that sheds light on the way attention can affect time perception. We can catch a ball or drive a car safely while constantly gauging times with precision, but overt timings are more difficult to get right.[19] Her explanation for the clock illusion has nothing to do with vision and everything to do with attention. Time, she suggests, is distorted because we have glanced across the room and are concentrating on something new. When we focus our attention on an event, even one as brief as looking at the clock, it creates the impression that it lasted longer than it did. Attention can also explain why boredom slows down time. Writing in the nineteenth century, the influential psychologist and philosopher William James suggested that boredom occurs when 'we grow attentive to the passage of time itself'. To illustrate this sensation, he suggested closing your eyes and getting a helpful person to tell you when a minute has passed. Try it: it seems like ages. And that silent minute will seem even longer if the preceding minute was filled with music or speech. Likewise the involvement of attention can explain why rejection slows time down. The rejection causes us to focus in on ourselves and our shortcomings, and once again time is stretched.

Whether we're falling through the sky or watching a clock, it is becoming clear that our relationship with time is not straightforward. Attention is just one part of the story; our shared understanding of time is another; and in the next chapter I'll ask how it is that the brain measures time at all, when there is no specialised sense organ for time.

Meanwhile we left Chuck Berry suspended in time in

mid-air on the New Year's Day gliding trip that had gone so wrong. By now he would surely have crashed to ground. Standing on Coronet Peak, his aviator friends had heard a bang. They watched as the wings fell off the glider and saw that Chuck was starting to fall, seemingly dragging the remains of the aircraft behind him. Then he disappeared. Why wasn't he opening the reserve chute? Without it there was no way he could survive.

With so much to think about Chuck had not felt particularly frightened; even though time had expanded, he didn't have time to be scared. He stretched his arm as far as he could and finally found what he had been searching for, the handle of the chute, flapping in the wind. He yanked it hard, yearning for that comforting sensation that comes when the canopy bursts into bloom and you begin to rock gently in your harness, as though picked up and cradled by a giant. But that didn't quite happen. He began to slow a bit, but knew he was still falling too fast. Looking up, he understood why. The chute was old-fashioned, small and round. 'Like the ones the airmen had on D-day?' I asked him. 'Like that, but ten times smaller.' Now he was scared. After all that he'd gone through, he was going to crash anyway. If only there were some trees. Usually he would do anything he could to avoid landing in trees, but at this speed and with a 2,000-foot drop, a fall broken by branches could be his only chance of survival. But there were no trees nearby, just the bushes on the steep slope of Coronet Peak. Time had been passing achingly slowly. Now everything changed. It was fast. There was no way of steering, and he crashed into the bushes.

Half an hour later he was still lying on the ground, strapped into the wreckage of the cockpit. He had no idea how he had got there. Looking down at his clothes he realised he must have been gliding, but here he was stranded on a hillside without a glider. Then he saw the Swift's wings higher up the hill.

The global positioning satellite system in Chuck's pocket provides some unintended data on time perception. It too survived the crash. So while Chuck's perceptions of the accident might tell him one story, the GPS and its accurate records of his precise location at each moment in time tells a different one. 'That freefall took forever. It was the longest time.' In fact that everlasting fall had taken just 10 seconds and the hurtle to the ground with the tiny parachute had lasted another five. After his crash, Chuck remembers calling the air traffic control tower in Queenstown to inform them about the accident. He only remembers one call, but the phone shows he spoke to them twice, suggesting he was confused, if not concussed. He lay high up on the side of the hill waiting for his rescuers. It was 40 minutes before they reached him, but now time was playing tricks on his mind again. It was speeding up. He was so elated that he was convinced they arrived in 10 minutes. 'I was just stoked to be alive, really. There's nothing better.' And as for injuries, he told me, 'I had a bump on the head and a prickle in the wrist. That was it.'

He puts his survival down to his many years of experience skydiving. To him freefalling feels normal, so he didn't panic. He's not given up on the adventure sports either and is now building his own plane. Chuck believes that two

decades of skydiving have changed his perception of time, and not just when things are going wrong. To most of us five seconds seems like a short time, but he knows that it's long enough to travel 1,000 feet when you're falling. He now thinks that five seconds is a long time. His experience is a good illustration of the way we each create a sense of time in our minds. To understand how we do it, it is necessary to look at the way the brain counts time.