1. MEANDERING BRAIN, WANDERING MIND

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'We're going through!' The Commander's voice was like thin ice breaking. He wore his full-dress uniform, with the heavily braided white cap pulled down rakishly over one cold gray eye. 'We can't make it, sir. It's spoiling for a hurricane, if you ask me.' 'I'm not asking you, Lieutenant Berg,' said the Commander. 'Throw on the power lights! Rev her up to 8,500! We're going through!' The pounding of the cylinders increased: ta-pocketa-pocketa-pocketa-*pocketa-pocketa*. The Commander stared at the ice forming on the pilot window. He walked over and twisted a row of complicated dials. 'Switch on No. 8 auxiliary!' he shouted. 'Switch on No. 8 auxiliary!' repeated Lieutenant Berg. 'Full strength in No. 3 turret!' shouted the Commander. 'Full strength in No. 3 turret!' The crew, bending to their various tasks in the huge, hurtling eight-engined Navy hydroplane, looked at each other and grinned. 'The old man will get us through,' they said to one another. 'The Old Man ain't afraid of Hell!' . . .

'Not so fast! You're driving too fast!' said Mrs. Mitty. 'What are you driving so fast for?'

So begins James Thurber's short story 'The Secret Life of Walter Mitty', first published in *The New Yorker* in 1939, and made into a film starring Danny Kaye in 1947 (a recent remake stars Ben Stiller). Mitty is the archetypal daydreamer. He is, of course, a fictional character, so he, and his mind-wandering, are really products of Thurber's own mind-wandering. The wandering mind is the source of fiction, as well as possible mishaps on the road.

The Chambers dictionary defines wandering in several ways, but the one I like best goes like this:

Wander /won'der/ intransitive verb. To go astray, deviate from the right path or course, the subject of discussion, the object of attention, etc.*

That definition seems to allow that we can wander mentally as well as physically. Mind-wandering often seems to afflict us when we're supposed to be concentrating on something, such as a lecture, a board meeting, or driving. It also gets in the way when we're simply trying to read a book. Jonathan Schooler and colleagues at the University of California at Santa Barbara had students read the opening chapters of Tolstoy's *War and Peace* for 45 minutes and asked them to press a key whenever they caught themselves 'zoning out'. They caught themselves an average of 5.4 times. The students were also interrupted six times at random intervals to see if they were zoning out at the time without having been aware of it, and this caught, on average, a further 1.2 times. So it's not just you, you might be relieved to know—we all seem to have trouble staying focused, especially on the books we're actually supposed to be reading. Or the lecturer we're supposed to be listening to.

Okay, you can now zone back in.

Sometimes, mind-wandering is intrusive even when you're not engaged in some more pressing task. Perhaps you've been on a long plane trip, trying to sleep. Somehow the mind won't turn off, but churns through tedious or worrisome thoughts. You might brood over some recent unsettling incident, or fret about a forthcoming

* In German, I'm told, 'wandern' simply means 'to walk', without any suggestion of deviating from the right path. Germany has a fine literary and artistic tradition, indicating that German minds can also wander in the sense intended in this book.

lecture. Of course, our wanderings can also be happy—anticipating a family reunion, or luxuriating in a recent promotion. Sometimes, too, the mind gets caught in an eddy, with thoughts that keep repeating.

As often as not, the eddy is a tune or jingle that won't go away. It's like a stuck record. This has been called 'stuck song syndrome', and the offending jingles are known as 'earworms'. The problem is how to get rid of them. One suggestion is to dump them on someone else. In his short story 'A Literary Nightmare', published in 1876, Mark Twain tells of a virus-like jingle that infects his mind for several days, until he goes for a walk with his friend the Reverend, and manages to transfer it to him. Twain later meets up with the Reverend again and finds him in distress—the jingle has so infected his thoughts and actions that the congregation in his church has started swaying to its rhythm. Twain takes pity on him and helps him transfer the jingle to a group of university students.

The jingle in question was based on a sign announcing the fares on a tram, and converted into a short song with a catchy tune. It runs as follows (skip this if you don't want to be infected):

> Conductor, when you receive a fare,
> Punch in the presence of the passenjare!
> A blue trip slip for an eight-cent fare,
> A buff trip slip for a six-cent fare,
> A pink trip slip for a three-cent fare,
> Punch in the presence of the passenjare!
> **CHORUS**
> Punch brothers! Punch with care!
> Punch in the presence of the passenjare!

The jingle seems to have gone on to infect popular culture, at first in Boston and especially among Harvard students, and then more widely. It was even translated into French and Latin. It was used by Robert McCloskey in one of his Homer Price stories, called 'Pie and Punch and You-Know Whats', as a cure for another persistent jingle. It was set to music in 1972 as part of a song cycle called *Third Rail* by Donald Sosin, and performed at several venues in the United States. The jingle has no doubt faded from the public mind as other annoying jingles have risen to take its place, which are best not mentioned here in case they stick and you can't get rid of them.

What the brain does while the mind wanders

The brain is active even when the mind is disengaged, or wandering from the task at hand. Early evidence that this is so came as a result of a German physician called Hans Berger (1873–1941) falling from his steed and landing in the path of a horse-drawn cannon. Fortunately for the future of neuroscience, he escaped injury, but his sister at home several kilometres away sensed that he was in danger, and asked her father to contact him. Berger took this as evidence for telepathy, which he thought might depend on some physical transmission of 'psychic energy', and might be measurable. In 1924, he decided to test this by recording electrical activity from two electrodes placed under the scalp, one at the front of the head and one at the back. Sure enough, the electrodes picked up electrical activity, although it was far too weak to suggest a basis for telepathy. The technique became known as electroencephalography (EEG). When the subject was in a resting state with the eyes

closed, the EEG showed a fluctuation in voltage with a frequency of 8 to 13 cycles per second, known then as 'Berger's wave' but more recently as the 'alpha wave'. When the eyes were opened, this wave was suppressed by the faster 'beta wave'. In later developments of electroencephalography, multiple electrodes are placed on the surface of the scalp, and can provide information as to where in the brain the activity is generated.

Later on, better techniques for witnessing activity in the brain were invented. In the 1970s, the Swedish physiologist David H. Ingvar, along with Danish scientist Niels A. Lassen, injected a radioactive substance into the bloodstream and tracked its course in the brain with external monitors. The blood flows to regions where neural activity is high, and Ingvar noted that activity was especially high in the frontal areas of the brain during resting states. He described this as representing 'undirected, spontaneous, conscious mentation'. In short, mind-wandering.

Since then, increasingly sophisticated methods of tracking blood flow and superimposing it on detailed anatomical images of the brain have given us much more precise maps. One technique, known as positron emission tomography (PET), also uses injection of radioactive substances in the bloodstream, while a less invasive technique known as functional magnetic resonance imaging (fMRI) uses a powerful magnet to detect haemoglobin, which is carried by the blood. In both cases, the movement of blood is superimposed on images of the structure of the brain. These techniques are used in clinical research to investigate brain pathology, but fMRI in particular is increasingly used in normal volunteers to map the brain networks involved in simple mental tasks such as reading, or recognising faces, or mentally rotating objects.

These techniques have allowed us to see which parts of the brain are active, both when a person is engaged in a task and when she is not. At first, it was assumed that activity during non-engagement was simply background neural noise, like static on an old radio. In studying the brain activity associated with a given task, such as reading words, it was supposed that one could simply subtract out the neural signal when the brain was idling from that when it was engaged in the task. It transpired, though, that blood flow to the idling brain was only 5 to 10 per cent lower than to the engaged brain, and wider regions of the brain were active during idling than during engagement on a task. The brain regions active during the supposedly resting state have come to be known as the 'default-mode network'. It was Marcus Raichle, a neurologist from Washington University in St Louis, Missouri, who coined this term, in 2001. 'To my great surprise,' he wrote to me, 'it has taken on a life of its own, for better or worse.'

The default-mode network covers large regions of the brain, mainly in the areas not directly involved in perceiving the world or responding to it. The brain is a bit like a small town, with people milling around, going about their business. When some big event occurs, such as a football game, the people then flock to the football ground, while the rest of the town grows quiet. A few people come from outside, slightly increasing the population. But it's not the football game we're interested in here. Rather, it's the varied business of the town, the give and take of commerce, the sometimes meandering activity of people in their communities and places of work. So it is in the brain. When the mind is not focused on some event, it wanders.

Mind-wandering can be under conscious control, as when we

deliberately replay past memories or plan possible future activities. Sometimes it is involuntary, as when we dream, or hallucinate—things that just happen to us whether we want them to or not. Sometimes it lies somewhere in between, as when we daydream, perhaps with the intent of considering some dilemma, or try to solve a cryptic crossword clue, but other thoughts intrude. As the American comedian Steven Wright complained: 'I was trying to daydream but my mind kept wandering.'

Mind-wandering plays cat and mouse with paying attention. In one study, Japanese researchers had people watch videos while recording their brain activity. Most of the time, the brain areas concerned with paying attention were active, but at natural breaks in the stream of events people would blink their eyes, and brain activity would momentarily shift to the default-mode network. Indeed, sometimes when people are supposed to be paying attention to something like a video, they blink more often than is necessary to lubricate the eyes. This is a sign that their minds have flitted away from the story.

Is mind-wandering bad for you?

Some have suggested that mind-wandering is not good for us, and one study suggests that it even makes us unhappy. The authors of this study exploited the age of the smartphone by devising an app that enabled them to contact around 5000 people from 83 different countries at random moments through their waking hours, and ask them what they were doing when interrupted. In 46.7 per cent of the samples, they were thinking about something other than what they were currently doing—or supposed to be doing. Their minds, in other words, were wandering. They were more likely to have wandered into pleasant thoughts than into unpleasant ones, and not surprisingly reported being happier when basking in the pleasantness than when grovelling in the unhappiness. But even when wandering into pleasant thoughts they were no happier than when their minds were not wandering. The study's authors assert: 'A wandering mind is an unhappy mind.' Perhaps, though, their happiness was diminished by being so rudely interrupted.

In one respect, at least, it is not surprising that we can be happier when actually engaged in an activity than when simply imagining it. In the study just mentioned, the activity that created the greatest happiness was making love. Simply imagining that happy activity understandably fails to match the bliss of the real thing. Well, most of the time, anyway. More generally, we may concoct joyful plans, but the joy is capped by the satisfaction of carrying them out. Conversely, events we dread often turn out to be less catastrophic than we feared.

Even so, there's more bad news. People whose minds wander a lot seem to have shorter telomeres (the repeated nucleotides at the ends of chromosomes) in immune cells, which is taken to be a sign of aging. Too much worry and introspection, and you'll die young. If I were you, though, I'd be inclined to take that with a grain of salt—although do remember that salt, too, increases the risk of cardiovascular disease and early death.

So you may well wonder why nature equipped us with wandering minds. Besides possibly creating unhappiness and premature death, our mental journeys are a hazard to driving and a general impediment to efficient performance. They may lead us to fail our

exams, forget our appointments, leave the stove on as we depart for a vacation. Teachers implore their pupils to pay attention, to stop dreaming, so that they might learn, and part of the unhappiness caused by mind-wandering may stem from the guilt at having been reprimanded for inattention in our youth.

As adults, we feel guilty that our minds are not on the job, perhaps when we're supposed to be marking a heap of exam scripts or sorting envelopes. Most people, it seems, find their jobs boring at times, and wish they were somewhere else, but then feel guilty for doing so. The rather bad press associated with mind-wandering seems to have stirred an interest in what has been called 'mindfulness'—a form of meditation in which we turn our thoughts intensely inward and remain locked in the present. The Buddha is said to have advised as follows:

> The secret of health for both mind and body is not to mourn for the past, worry about the future, or anticipate troubles, but to live in the present moment wisely and earnestly.*

Rather than allow our minds to roam around the mental landscapes of past and present, or gardens of joy or anguish, we are urged to remain within our own skins, moving a spotlight of attention from one part of the body to another, or intently examining the sensations of breathing. I have no doubt that such techniques can restore a mental calm, although one may well wonder whether mindfulness, any more than mind-wandering, actually helps us get focused on the things we must do.

In any event, the news about mind-wandering is not all bad. Italian researchers found that excessive mind-wandering, even when shorn of what they call 'perseverative cognition'—rumination and worry—may have negative effects on health in the short term, but no detectable effects a year later. It seems we are programmed to alternate between mind-wandering and paying attention, and our minds are designed to wander whether we like it or not. In adapting to a complex world, we need to escape the here and now, and consider possible futures, mull over past mistakes, understand how other people's minds work. Above all, mind-wandering is the source of creativity, the spark of innovation that leads in the longer run to an increase rather than a decrease in well-being. It is even suggested that we have entered a new era of education that recognises creativity and problem-solving, rather than simply 'drilling the rote memorisation of facts and figures'. Maybe we should stop feeling guilty about mind-wandering and learn to revel in our Mitty-ish escapades.

In the following chapters, I discuss some of the components of mind-wandering, often with an eye to its likely adaptiveness and evolutionary origins. I will suggest that even rats may indulge in mental perambulations. But I begin with the faculty that must lie at the heart of our wandering minds. It's called memory.

* Actually, this quote seems to come from the translation of a Japanese book called *The Teaching of Buddha*, and placed in hotel rooms as a Buddhist alternative to the Gideon Bible. Don't worry too much about it.