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In Praise of Walking

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1.
WHY WALKING IS GOOD FOR YOU

We overlook at our peril the gains to be made from walking, for our health, for our mood, for our clarity of mind. Many of us live now in a deeply unnatural environment, where we spend long periods of the day sitting with our eyes focused on screens, perhaps a half-metre or so from our eyes. When we stand up, and then walk around and move about, our posture changes, with our torso and spinal column shifting to a single vertical axis from our head down through our back, and, through our legs and feet, contacting the ground. By contrast, when we sit, the weight of our body trunk is largely concentrated on the lower back, and in particular, on the coccyx, that little collection of bones that comprises our vestigial human tail.[1] The coccyx anchors a remarkable lattice of tendons and muscles extending across the spine and down the upper legs in particular, the gluteus muscles of the upper thighs, which are vital for walking. Little wonder that lower-back pain is one of the most common ailments in the developed world.

How silly, then, that the remedy – to regularly get up out of your seat and walk about – is so little understood or practised. Long periods of immobility also cause changes in muscle: fatty deposits build up in leg muscle, and, as we age, we lose muscle mass in part because of our immobility ('sarcopenia'). There are many other changes too: our blood pressure changes, as does our metabolic rate (the rate at which we burn energy). But when we stand up, things suddenly change in brain and body: we become 'cognitively mobile', our minds are in movement, our heads swivel, our eyes dart about. Our brain activity changes when we move about, with electrical brain rhythms that were previously quiescent now engaged and active. We become more alert, our breathing changes, and our brains and bodies are readied for action. The French philosopher Jean-Jacques Rousseau commented that 'I can only meditate when I am walking. When I stop, I cease to think; my mind only works with my legs.'[2]

Here's a walking memory of mine: I'm at a student conference in Belfast during the dreary and seemingly never-ending 1980s. I take a long walk up the Malone Road, past Queen's University into the centre of town. I pass through the numerous security cordons. Young soldiers with serious weapons are patrolling the city, looking in shopping bags for bombs and guns, talking nervously to each other in English accents. There's plenty of tension in the air. The Loyalist politician Ian Paisley's campaigning against the Anglo-Irish Agreement is a constant backdrop, as are the terrible atrocities, the many bombings and murders. The city is alive, though. A city is hard to kill.

When I cast my mind back over this walk on my first visit to Belfast, I remember that I walked past the much-bombed Europa Hotel. I then walked east toward Botanic Avenue, and then took a long loop back around the streets and roads to the rear of the Europa Hotel. Why this route? Just because I could; that's what being on foot does for you. It's early Saturday afternoon, the weather is grey, and there's a hint of rain in the air. Wandering about, I accidentally find myself walking on Sandy Row, the Loyalist epicentre of Belfast. The murals are amazing, and a little frightening, to someone from the sedate and peaceful south. I walk quickly on, eventually connecting with the Lisburn Road, and finally find my way back to where we students were all staying on the Malone Road. Here, in Belfast, a walk is a walk into a past that is still present; as the old maxim has it, 'the past hasn't even passed'.

Wrapped up in this little personal journey are many of the elements of the hidden story of walking: mental time-travel to recall details, reminiscences about a walk, orientation and successful navigation through an alien urban environment, the little frisson of fear that still comes to me when I remember the security cordons and the murals. We now know that the brain systems relating to all of these functions are in constant communication and support each other's functioning. And, crucially, these brain systems are not perfect. My memory has tricked me a little. It has simplified the route, and left out significant details. I remember Botanic Avenue as being almost opposite the Europa Hotel. It's not, as a look at a map tells me. Botanic Avenue is at an acute angle that runs on to Great Victoria Street, which is actually where the Europa Hotel is. And, weirdly, I have excised most of the detail about the relative location of Sandy Row and the Europa Hotel. I remember

Sandy Row as more or less directly behind the Europa. It's not: Sandy Row is further south than that. I am left to imperfectly recall the gists of locations, places, things; I do not possess a faithful video recording somewhere in my brain of the route I took all those years ago.

This is the key point underlying our episodic and event memories: they are imperfect, gist-like, extracting meaning, focusing on certain salient points, and ignoring others.[3] There is more information out in the environment than our mobile minds can capture, and more than we need to know. How we move, what we look at, who we talk to, what we feel as we move: these are central components of our experiences. They might enter into our recall and be laid down as traces in our brains. We are not disembodied brains travelling through space and time: we feel the ground beneath our feet, the rain on our face; perhaps peering into the unknown, but in doing so we are extending our range of experiences of this complicated world. And all the while we are silently creating memories of where we have been, and making maps of the world we have experienced.

It's possible to demonstrate the brain-changing power of simply getting up and walking about. A straightforward experiment called the 'Stroop' task – devised by American psychologist John Ridley Stroop[4] – is used to test 'cognitive control', in other words, the ease or otherwise with which you can direct and control your attention and thinking. The Stroop task is a colour-and-word identification task with a twist. Participants are presented with lists of colour names (red, green, blue, black, etc.). These are printed either in the same colour (for example, the word 'red' printed in red) or in another colour (the word 'red' printed in green). Participants are asked to, as quickly as they can, name the colour of the printed word. Typically, when the printed word and the colour it names are congruent, response times are rapid and accurate. By contrast, when the printed word and the colour it names are incongruent, response times are much slower.

Often, Stroop-task performance is impaired under dual-tasking conditions. For example, a participant might be asked to engage in the colour naming, while simultaneously monitoring sentences played through earphones, and listening out for a particular word or phrase which they must identify by pressing a button. The Stroop effect is very reliable and easy to detect; it is often explained as requiring the paying of selective attention to certain aspects of the visual stimulus, while actively suppressing attention to other (automatic, attention-grabbing, prepotent) aspects of the visual stimulus, and then selecting and making the appropriate response.

But what happens if you add movement into the mix? The experimental psychologist David Rosenbaum and his colleagues at Tel Aviv University wondered if merely standing up might have an effect on Stroop performance.[5] They found, over a series of three experiments, that when a participant is standing up, the Stroop effect for incongruent stimuli – where performance should be slower – is, in fact, faster than is normal compared to when they are seated. It is as if the mere act of standing mobilises cognitive and neural resources that would otherwise remain quiescent. Moreover, recent studies show that walking increases blood flow through the brain, and does so in a way that offsets the effects of sitting around.[6] Regularly interrupting prolonged bouts of immobility through the simple act of standing up changes the state of the brain by calling on greater neurocognitive resources, constituting a call to action as well as a call to cognition.

As well as improved cognitive control, it's clear that walking confers many, many other benefits. We all know that it is good for our heart. But walking is also beneficial for the rest of our body. Walking helps protect and repair organs that have been subject to stresses and strains. It is good for the gut, assisting the passage of food through the intestines.[7] Regular walking also acts as a brake on the ageing of our brains, and can, in an important sense, reverse it. Recent experiments asked elderly adults to participate in thrice-weekly, and relatively undemanding, walking groups.[8] In the regular walking group, over the course of a year, the normal ageing of the brain areas providing the scaffolding for learning and memory is somewhat reversed in the walkers, by perhaps about two years or so. An increase in the volume of these brain areas was also found; this is quite remarkable in itself, suggesting that the act of regular walking mobilises plastic changes in the very structure of the brain, strengthening it in ways similar to how muscles are strengthened when worked.

One way of interpreting the literature on ageing and walking is straightforward: you don't get old until you stop walking, and you don't stop walking because you're old. Lots of regular walking, especially if conducted at a high tempo, with an appropriate rhythm, forestalls many of the bad things that come with ageing. Walking is also associated with improved creativity, improved mood, and the general sharpening of our thinking. Periods of aerobic exercise after learning can actually enhance and improve recall of the previously learned material. Reliable, regular, aerobic exercise can actually produce new cells in the hippocampus, the part of the brain that supports learning and memory. Regular exercise also stimulates the production of an important molecule that assists in brain plasticity (known as brain-derived neurotrophic factor, or BDNF).[9] The phrase 'movement is medicine' is correct: no drug has all of these positive effects. And drugs often come with side effects. Movement doesn't.

When walking in the beautiful Glendalough valley once, I felt the thrumming of many running feet. I stopped, and was treated to the sight of four or five red deer running through the glen. It was late autumn, breeding season, and I could hear the stag roaring and calling. This is something else walking does for you: you see, smell and feel things as they are, not through a windscreen at speed. Walking allows you to confront the personal, instead of insulating you from it. Like many people, I also drive, and I always take the train to work. But walking is special to me as a form of transport. Walking allows me to walk it off, whatever *it* is. Walking clears my mind, allowing me to think things through. Natural movement brings with it experiences and demands on the body and brain that do not arise from other types of movement. Cars, bicycles, trains and buses all divorce you in different ways from the environment, you are mechanically propelled, sometimes insulated behind glass, travelling too fast, worried about crashing, trying to find that new song on the radio. There is a peculiar passivity to it: you are sitting, yet you are moving at speed. This can never be true of walking: one foot must go in front of the other until you get there, under your own steam. You make your own way, and experience the world close at hand, at your own speed, in your own way.

But, how do we know that walking has all these multifarious benefits for our minds, bodies and quality of life? What's the evidence? The evidence is extensive and, as we will see in the course of this book, shows that walking enhances every aspect of our being, from our physical health, to our mental health, to our social lives and beyond.

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This may seem an obvious point, but when we're walking our brains are in motion too. In fact, as we shall see, we evolved as a mobile species: we walk about, we move, we seek new sources of information from the world. In other words, we are not just brains locked in a skull, we are minds in motion – we are 'cognitively mobile'. The study of how we think, how we reason, how we remember, how we read, how we write, is known as the study of cognition. Typically, the scientific investigation of cognition occurs in a laboratory, using carefully controlled experiments and a range of methods and tests that measure cognitive abilities.

Almost anything that moves in a reliable and consistent way can probably be measured somehow. The movements made can be various and manifold. They might be the pattern of eye movements that a person makes: where they look, and for how long, at particular locations on the screen can be captured; the rapid flickering of increases and decreases in pupil size might be measured; the electrical responses of the brain might be analysed; reaction times might be assayed; how much the person fidgets in the experimental chair ascertained. And, in the latest generation of experiments, participants might perform these complex tasks while lying in a brain-scanning machine, which uses a variety of advanced methods to measure and to localise activity in the brain associated with the performance of a particular cognitive task.

There are two principal methods of brain imaging. The first and by far the most popular is magnetic resonance imaging (MRI), which comes in two principal flavours: functional (thus, fMRI) and structural (sMRI). MRI is a medically safe, non-invasive procedure that allows you to (in principle) see the brain at work with details down to the millimetre. The other major brain-imaging tool is positron emission tomography (PET), which involves the injection of radioactive tracers into the blood, and mapping their uptake in differing brain regions during differing tasks. PET is a technique with comparatively poor spatial localisation, compared with MRI, and is a little unpleasant, especially if you have a needle phobia. PET has found specialised uses particularly in the development of new drug treatments for brain and other disorders. MRI, by contrast, does not involve any injections, and offers much greater localisation in terms of structure and function. MRI and PET have allowed us an unprecedented view of the brain at work – and especially of the human brain at work.[10]

Let's now imagine you are asked to participate in an fMRI experiment. You are placed on the bed of the MRI scanner, and slowly inserted into the bore at the centre of the machine. First up, an sMRI: a picture of multiple slices through your brain, to check that there are no abnormalities or other problems present. Assuming this goes smoothly, you will then be instructed in the task you will perform in the fMRI. Here, you will first gaze at a small cross on a screen (this is called eye fixation), and then you will be asked to perform a task. Keeping to the theme of this book, this task might be a spatial navigation task. You might have a joystick, and you have to find your way around a complex three-dimensional maze. We can predict, based on what we know from experiments on rats and on humans, that we will see a very high degree of activity in the hippocampal formation, as well as activity in brain regions involved in motor movements. How do we show there is activity in the hippocampal formation, specific to the task, and not to other aspects of the task? Here is where control experiments are absolutely essential. Often, a subtractive logic is employed: task-irrelevant activity is subtracted from the task of interest. You might ask the subject to move the joystick according to a verbal instruction, but not while exploring the maze, so that they are engaged largely in visuo–motor behaviour.

This laboratory-based, experimental approach has been remarkably powerful. It has allowed us to test and extend the standard model of human cognition. However, it does come with certain limitations. The particular limitation we concern ourselves here with is our ability to measure what it is that goes on in the brain while the brain is moving around, when the mind is mobile 'in the wild', as it were. The experimental psychologist Simon Ladouce and his colleagues at Stirling University argue (correctly, in my view) that our understanding of cognition has progressed more slowly than it could or should have done, because past and current generations of psychologists and neuroscientists have not studied mobile minds and brains with the intensity that perhaps we might have done.[11] To be fair to legions of experimenters, this has occurred of course because putting the lab into the wild is difficult. Studying the actions of the mind in motion can be done, but it is not easy. Realistically, to study cognition in the wild requires taking what is best of laboratory practice and somehow making lab instruments mobile so that we can measure what it is that people think, say and do while they are walking about.

The latest generation of mobile technologies are becoming well known to us all and these can be adapted and used to capture behaviour while we are out and about. Many, if not most, of us now have smartphones. These usually now come equipped with apps to measure the number of steps, speed of walking, our diet and many other things besides. Expanding on these and other technologies allows us to capture more of what the brain is doing when cognition is mobile. Smartphones have proven to be particularly useful. Participants can be pinged at different times of the day and they can be asked what they are doing, how they are feeling and what it is they are planning to do, among other questions. This is known as 'experience sampling'.[12]

While there are indirect ways of studying how walking changes the brain, specifying and understanding the underlying mechanisms can be more difficult. Relating these changes to the activity of these brain cells, circuits and systems to overall cognition and behaviour is more difficult still. However, we do now have the beginnings of an understanding of how walking affects activity in the brain. In turn, we are now starting to understand how walking changes the brain in order to prepare for action.

Imagine for a moment being a cat, sitting and waiting for your prey. There's a rat nearby which, in turn, is moving about looking for something tasty to eat. Imagine being that cat, stealthily stalking the rat. Your visual system is more sharply attuned simply because you are moving quietly about. You pick up information more quickly; your paws are readied to capture your prey.

Now imagine being the rat heading back to a burrow or nest. It is semi-dark, and cat-you and rat-you are both operating at the edges of your visual acuity. You can, perhaps, each smell the odour trail of the other, but the odour trail is, perhaps, indistinct and does not provide a reliable path to track down the prey, or escape from the predator. Unless your place of refuge is completely secure, the better escape strategy is to move quietly and carefully, relying on the extra tuning that your visual system has when walking. Similarly, moving around, moving your head, your eyes, allows you a better chance at picking out your prey – the meal that you so badly need tonight.

Here, we have an interesting 'evolutionary arms race'. Activity in the visual areas of the brains of both the rat as prey, and the cat as predator, is sharpened and tuned by walking.[13] Walking allows you to capture your prey more easily, but equally walking allows you to escape the predator more easily. There are two competing mobile cognitive systems, one cat-based, one rat-based, each tuned to defeating the aims of the other. And the activity of each system is sharpened by the same thing: walking. This leads us to an important, and general, conclusion: walking markedly changes activity in the brain in subtle, important and powerful ways.

This cat–rat, predator–prey example allows us to consider mobile cognition by thinking through what happens to activity in brain cells, circuits, systems and then behaviour. What happens to your sense of how you see things when you are walking? Does walking affect seeing? How fast can I see something when I'm walking and paying attention, compared to when I am sitting and paying attention? Walking changes activity in the parts of the brain that are concerned with seeing, and it changes them in a variety of positive ways, designed to make responding to what is happening in the real world quicker and more effective.

Let's think for a moment about how cognition might be affected by movement. We can think of the brain (somewhat simplistically, it has to be said) in the following way: the brain receives inputs from the outside world (the sensory side of the nervous system), and processes these in some way (the central component of the nervous system). In turn, the results of this processing can affect behaviour through some form of output (the motor side). Activity in these differing component parts can then be measured during walking. And the picture that emerges is that walking measurably changes brain activity for the better. Hearing, sight and reaction times all improve during active movement.

Of course, we're not simply layabouts; and our mobility presents particular problems for data collection. As we shall see, conducting experiments with mobile rats and mice is now relatively straightforward. Experiments in mobile humans, however, require somewhat more ingenuity.

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The Via Alpina, or Alpine Way, courses over eight countries (Austria, France, Germany, Italy, Liechtenstein, Monaco, Slovenia and Switzerland), and consists of five lengthy interlocking trails. These trails amount to about 5,000 kilometres. The Via Alpina trails are truly ancient in origin, and occasionally, archaeological finds on the trails tell interesting and disturbing stories of their past. In one such case from 1991, a 5,000-year-old mummy of a middle-aged male was discovered on what is now the Austrian–Italian border. He was given the name of Ötzi the Iceman.[14]

Poor Ötzi had come to an unpleasant ending: X-rays of his body showed that he had been struck in the left shoulder by a deeply embedded flint arrowhead, and had then been hit hard on the head. His arms show some defensive wounds. It's not entirely clear which wound killed Ötzi. Neither the arrowhead nor the strike to his head are likely to have resulted in instantaneous death. He may simply have died as a result of blood loss from his shoulder wound. Almost inevitably, it seems, in death Ötzi would suffer further indignities – he's become quite the celebrity on the Via Alpina, with local restaurants now serving Ötzi pizza, and Ötzi ice cream.[15]

How does Ötzi compare with a modern human? Ancient humans would very often have been nomadic, unlike their more sedentary twenty-first-century brothers and sisters. How would this nomadic lifestyle have affected Ötzi's body?

A 2011 experiment was able to roll back the years, allowing us to see what his body might have looked like and how it would have changed because of this nomadic lifestyle. Researchers studied how a sixty-two-year-old, reasonably active male adapted and responded to walking the long trail across the Alps. The unnamed Italian man walked 1,300 kilometres of the Via Alpina over the course of three months.[16] Before starting, he reported to the laboratory where he was measured from tip to toe. Measures were taken of all of the critical aspects of his bodily functioning: his breathing capacity, his muscle strength, how lean his body was, the various components of his blood, and a whole variety of other measures. He was then equipped with a mobile physiological laboratory that he carried with him. This laboratory in miniature consisted of instruments in a rucksack, along with tools to allow him to repeatedly take and measure his own blood chemistry. The portable devices allowed the researchers to develop a picture of our modern Ötzi's ongoing adaptation to his prolonged mountainous trek.

And the good news here is that it is never too late for anyone to start walking, even over long distances. Despite being reasonably fit, our modern-day Ötzi had never taken a journey on foot of this length and duration before, yet the measurements showed that his body adapted quickly and easily to the rigours of the journey, including overcoming the effects of mild oxygen starvation at altitude. (The Via Alpina varies between 0 and 3,000 metres above sea level; altitude sickness usually happens above 1,500 metres, where oxygen levels drop to 84% of the oxygen available at sea level. By 3,000 metres, oxygen levels drop to 71% of the oxygen available at sea level.)

There were positive changes in virtually every single measured area of his functioning. His body mass index – often used to determine obesity – declined by about 10%. On the other hand, his percentage of measured body fat fell dramatically, by about a quarter in total, as a result of the continued exercise of the journey. (Need to lose weight? Don't go to the gym; go for a really, really long walk. And do it in nature, over a period of days to weeks. It will be far more beneficial to you.)

Overall, our modern-day Ötzi walked just over 1,300 kilometres in sixty-eight days – about 19 kilometres a day – although there was considerable variation in the amount he walked each day: on some days he only managed about five or six kilometres, whilst on other days he clocked up to forty-one kilometres. This variation, of course, reflects the difficulty of the underlying Alpine terrain. Five kilometres walked while ascending perhaps 2,000 metres over a rocky mountainside trail is a considerable achievement indeed, whereas walking forty kilometres on a gentle, well-maintained, downward trail over a seven- or eight-hour period is perhaps, relatively speaking, not such an onerous walk. The length our modern Ötzi walked is comparable to other endurance walks that other humans have engaged in. It's this ability to walk substantial distances over difficult terrain, in relatively short periods of time, by making steady, reliable, daily progress that was key to our species' long journey out of Africa, as we'll see in Chapter 3.

One especially important benefit to our modern-day Ötzi was a major and sustained decrease in the kinds of fats (triglycerides) thought to underlie at least some forms of heart and cardiovascular disease. His extended walk resulted in an approximately 75% decrease of these triglycerides. There was also a large increase in the production of fats (high-density lipoproteins, of the sort found in olive oil and fish oil) believed to protect the heart. So, here we have strong evidence from a deep case study of a late-middle-aged male that an exercise regime based on daily walking can markedly protect the heart, not just by making the heart fitter (although it certainly does this), but by reducing factors in the bloodstream that can cause heart disease. We can conclude from this case study that, even in late middle age, the body, motivated appropriately by its brain, can adapt dramatically and for the better as a result of an extended period of daily endurance walking.

Are these bodily changes an anomaly, or do they reflect some underlying general set of processes, common to us all? Our Italian participant's inflammatory and other markers of disease also fell dramatically across every single one measured. Does he have some physiological peculiarity, or some odd genomic idiosyncrasy responsive to such extended periods of walking?

Testing very remote, unconnected human populations is one way to rule out such concerns. A study conducted in Bolivian Amazonian hunter-gatherers suggests that they too are similar to our modern-day Ötzi (or, rather, that he responds to activity in the same way they do). The evolutionary anthropologist

Hillard Kaplan and colleagues from the University of New Mexico conducted a study on 705 members of the Tsimane who live in the Amazonian jungle.[17] These are hunter-gatherers who live principally on a diet of fish, wild game and high-fibre carbohydrates. They have a very low dietary intake of low-density lipoprotein, or LDL. Smoking is vanishingly rare among the Tsimane (although they are subject to high levels of parasites). The Tsimane are very active during the course of the day, occupied by farming, hunting, food preparation, household chores and parenting. They walk everywhere and do not used wheeled transport, or ride animals.

Remarkably, Kaplan and his colleagues found that almost all Tsimane tested have markers of cardiac health that are better than the healthiest Western societies. Coronary artery calcium (CAC) scores are a measure of the extent to which there are calcium plaques (with a build-up of fats and other materials and detritus) in arteries. These plaques can solidify and even eventually block the free flow of blood through an artery, causing heart attacks and strokes. The CAC scores of the Tsimane are a fifth or less of those of Western populations, and fully 65% of them have a CAC score of zero. So an eighty-year-old Tsimane actually possesses the vascular age of an American in their mid-fifties.

Although the study did not include actigraphy (direct measurements of movement), observational data collected suggests that the Tsimane spend many hours per day engaged in physical activity – multiples of that found in a Western, sedentary, industrialised population. They spend time food gathering over extended distances, hunting, fishing, foraging and other activities necessary for survival. We can safely and reasonably conclude that high levels of activity (principally walking) can, along with dietary changes, markedly help protect the heart against factors that promote heart disease. Moreover, these factors can be reversed both by activity (for the better) and inactivity (for the worse). Modern-day Ötzi shows that these malign changes can be reversed quickly, by walking, and walking lots, whereas a sedentary lifestyle worsens them.

Sadly, no records were taken of our modern-day Ötzi's mood. I am willing to bet, though, that we would see two differing components of his mood. His moment-to-moment mood would have reflected the ongoing challenges of such a walk: being wet, too hot, too cold, or hungry and thirsty; being frustrated with the inconveniences of a nomadic life (where do I sleep? Where do I eat? Where can I go to the loo?). But his long-term sense of well-being, as well as clarity of thinking or indeed clarity of consciousness, will have moved upwards, perhaps enduringly so.[18]

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Whilst our Italian guinea pig was outfitted with a mobile laboratory to measure his functioning, modern-day technology gives a new and more convenient solution for studying mobility and activity in the population at large, as mentioned earlier: the smartphone. Smartphone apps can passively track our walking steps and walking routes. We can log our age, weight, track our heart-rate and even our blood-oxygen levels. We can measure our relative activity levels in ways that were unimaginable a decade ago.

I always try to keep track of the number of steps I take every day, using my smartphone. I have a target that I attempt to hit as a minimum per day, though I'll often try to exceed it.

Why do I use a smartphone? The simplest reason is that it is impossible, without smartphone or other pedometer data, to actually track your walking steps reliably and consistently. It is difficult to remember how much walking you do from one day to the next. And it is next to impossible to know your average walking speed from hour to hour and day to day accurately without some form of pedometer. Having the data to hand allows you to calibrate how much you actually walk against what you think you walk; there is no way to gild the lily on this. Self-reporting is subject to all sorts of individual failures and problems.[19] We are reasonably good at providing relatively accurate statements about how we are currently feeling, but reporting on how we felt seventy–two hours ago is a different matter entirely. Capturing walking data reliably and consistently allows you to have a really fine-grained picture of how much walking you do, and when you do it, over the course of a day. A smartphone really can be your personal, individual lab in your pocket.

Smartphone penetration has increased dramatically in all societies and across all income groups, in both the developed and developing worlds. This almost total smartphone penetration now allows the capture of both individual-level walking data and country-level walking data, with high precision, over long periods of time. This is perfectly illustrated by the size of data sets now available; for example, computer scientist Tim Althoff and colleagues at Stanford University created a data set consisting of 68 million walking days captured from 111 countries, involving 717,527 people, aged from their mid-teens to their mid-seventies.[20] This is what the phrase 'big data' actually means: a vast lake of data, made of up almost uncountable drops of data gathered from hundreds of thousands of people.

After performing a variety of data checks and data clean-ups, they ended up with a final data set comprising 66 million walking days from 46 countries, involving 693,806 people. They were also able to capture age, body mass index (BMI), and gender, and went on to use this data set to build up a picture, at the country level, of patterns of activity regarding human walking. Additionally, they were able to use another data set from the US, which analyses – across a variety of measures – the walkability (or otherwise) of 69 US cities, from across the whole of the US. Importantly, as we will see in Chapter 5, some of these cities are from the same geographic locale, are similarly affluent, and have similar demographics, but show great differences in levels of walking, depending on the walkability of the city. They found huge variations within and between countries for the number of steps taken by individuals in each country. The best predictor of obesity, as measured by body-mass index (BMI), is not the absolute number of steps taken by individuals within any country, but rather the inequality in the number of steps taken within a country between males and females.

All sorts of interesting details came out of this study. For example, males walk more than females at all ages, from the mid-teenage years through to the seventies. On the other hand, females on average have lower BMIs than males. BMI, however, increases on average for lower activity levels. The average person in their analysis took 4,961 steps per day (though there was considerable variation behind this average, from above 14,000 steps to just a few hundred steps per day). There was also considerable country-to-country variation. In Japan, for example, the average number of steps taken per day was 5,846, whereas in Saudi Arabia, this figure was 3,103. The gender gap in steps walked was apparent across all countries tested, and in large part this gender gap gave rise to a substantial fraction of the observed differences in BMI.

What use do I make of my own personal, pocket-dwelling, laboratory? My smartphone walking app is a goad to action, no doubt about it. The step counter is my guilty conscience. I always want to hit at least 9,500 steps per day, which my phone records, but I prefer getting above 12,000 steps per day and am really happy with more than 14,000 steps per day. I now tend to make the 9,500-step target almost every day in each month, and hit 12,000 steps about eighteen days per month, and 14,500 steps about ten days per month. There is no way that I could remember with any consistency or accuracy the number of steps I take per day, without using pedometer data from my smartphone. My self-report data would be utterly unreliable. And this is fine: we should offload these dull tasks to pocket-held robots.

Why have I chosen these step targets? Well, in part because the smartphone app that I use allows me to measure my own performance against those of the population of people using the app more generally. Knowing how important activity is for health, I think it reasonable in my own case to ensure that I am at least consistently in the top 20% of the population that use my particular smartphone and its native app. Is this a reasonable target? Well, without knowing the population level data that Althoff and colleagues have captured, I might be subject to peculiar biases captured just by my smartphone app. It appears not, and it appears further that my own step targets are reasonable (at least compared to others).

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Beyond health, walking brings many other benefits for brain, body and behaviour, which we'll go on to explore throughout this book. We'll also discuss the many poets and writers who have written eloquently on the wonders of walking as a spur to mood, creativity and thinking. Writers are amongst the best at recognising walking's essential and intrinsic virtues and rewards. The poet I return to, time and again, is T. S. Eliot. I find Eliot's poetry has a cadence and rhythm that are remarkable, especially if read aloud. His great modernist poem 'The Love Song of J. Alfred Prufrock' (1915) is a journey on foot, and a journey through states of mind. It is a poem set to the rhythm of a long urban walk, undertaken uncertainly as evening falls. The opening lines are an invitation to walk the city:

> Let us go then, you and I,
> When the evening is spread out against the sky
> Like a patient etherized upon a table;
> Let us go, through certain half-deserted streets,
> The muttering retreats
> Of restless nights in one-night cheap hotels
> And sawdust restaurants with oyster-shells

Eliot extends an invitation to an unspeaking, and unseen, other to walk with him in the late evening, to explore on foot the low areas of the city. The journey on foot is essential to the cadences of the poem. Eliot does not ask the unseen other to cycle with him, to take a cab with him, to travel in the train with him. It is an invitation to walk.

Walking promises types of experience denied other forms of transport, no matter how attractive they might be. There will be the sights, conversations, the sounds of others, the smells of the lonely, window-ledge pipe-smokers who will be seen at 'dusk through narrow streets'. The feeling is one of Eliot having a conversation with himself whilst walking. There is a blurring of interior and exterior worlds, while Eliot, as Prufrock, walks uncertainly along. The poem is a notable, though oblique, tribute to walking and wandering in the urban and social worlds; the walking tempo carries you along through an imagined evening.

As Eliot says, 'Let us go', and explore now the wonder that is walking: all of it. The science, the history, the complex interactions of bone and muscle and nerves, stumbling, ambling, mooching, wandering, traipsing, strolling, tramping, striding, stepping. Our journey will take us from ancient Africa, to the mechanics of movement, into the innermost recesses of the brain as it maps the globe, to walking in concert and with purpose in order to change the world.