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Brain Hygiene, Optimising Expertise and Performance

This chapter explores how to ensure that best performance is achieved during the course of learning.

Expert performance is on-the-job execution to a high standard of the work or task that you are engaged in, by bringing to bear your capacities, abilities, resources and attention to execute the task to a demanding standard. In this chapter I will be examining some of the most important factors associated with on-the-job performance, including learning and memory, and other important factors that underpin these such as sleep, aerobic fitness, self-control, motivation and mind-sets/conscientiousness. First, though, let's undertake a thought experiment. I want you to imagine that you're a taxi driver in London, one of the world's oldest, largest and complex cities. A city in a constant state of flux with more languages in use than almost anywhere else on the planet; it is Europe's largest city, with a population not far off nine million people. You've been driving this city for years; you are not allowed to rely on sat-nav systems, unlike other drivers. To qualify as a taxi-driver, you have learned the route between any two points in a city with 25,000 streets in an area of 113 square miles. What effect does this have on your brain? Well, we can think of the brain as muscle—it develops as a result of training or cognitive exercise—the 'use it or lose it' principle. In a now famous set of studies of taxi-drivers, Eleanor Maguire and her colleagues (2000) studied spatial memory in expert and novice London taxi-drivers. Expert taxi-drivers were found to have larger right hippocampi than novices and controls. There are two possibilities: these individuals became taxi-drivers because of their enlarged hippocampi *or* the hippocampus *grew* because

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of repeated learning and exposure to routes. The flipside of this plasticity is that cells and connections may atrophy and die from *lack of use*, hence the drive to keep the mind active into old age, to prevent cognitive deterioration like Alzheimer's disease and dementia. The lesson is clear: a healthy mind and body requires activity.

Brain Hygiene, Sitting and Exercise

A question is floating around the blogosphere: *is sitting the new smoking*? A theme of this book is that aerobic exercise is good for the brain in a whole variety of direct and indirect ways. We know with certainty now that regular aerobic exercise is absolutely vital for good heart health. Less widely appreciated is the fact that the heart is, of course, directly connected with the brain, and the quality of blood flow through the brain has a dramatic effect on brain function. This manifests itself in a variety of ways. These include what appear to be decreased rates of dementia among those who are aerobically fit. Humans are not designed to spend long hours sitting around. Our metabolic rates rise substantially when we make a simple transition from sitting to standing. Our (orthostatic) blood pressure also changes when shifting from sitting to standing. Humans as a species have migrated to every geographic locale on the planet, from the Arctic to the Antarctic. No other species has done this. We haven't done this because we are the fastest runners, or the fastest at flying, or because we are the fastest at crawling. What we excel at is walking very long distances over long periods of time. It should be no surprise that walking in nature and walking generally is a remarkably good relaxant, a remarkably good anti-stress treatment and even one of the very best treatments for lower back pain (which may of course arise from excessive periods remaining seated). Modern work practices, where we spend long hours seated facing computer screens or in meetings, need simple but effective behavioural design changes. These changes manifest themselves in all sorts of other positive ways, from an enhancement of subjective wellbeing in staff to increased productivity.

Anecdotal evidence suggests that meetings conducted while walking or standing tend to be over more quickly and to be more to the point than the traditional seated format. There is another important possibility, which has as yet gone unrecognised in the literature. Many meetings are conducted, for reasons of architectural convenience, around a table where participants can focus on the eye position and eye gaze of others. We human primates, in fact, have a very elaborate eye positioning system in the brain (the 'oculomotor' system), which is coupled with another system designed to judge the movements of others, including the eye movements of others (the 'mirror neuron' system). Humans famously engage in displays of aggression or hostility by means of an unwavering gaze of the eyes. A walking meeting offers the chance to break this script. When walking, eye movements are directed frontally and in a common direction, and lateral movements are much less frequent and are signalled usually by a head movement. A walking meeting, therefore, offers an important opportunity to conduct a short, focused discussion around what might be a contentious or difficult issue, with the latent cues that exacerbate hostility and anger (in particular, eye gaze and fixation) removed. Furthermore, because walking is conducted typically in outdoor settings, the temptation to violate social norms through shouting is reduced, because of the unwanted attention that raised voices will bring to the group. It may well be that a walking meeting of this type will only walk best where a small number of participants are involved. An important literature suggests that walking or mobility also contributes to positive mental health in a variety of ways. Epidemiologically, those who walk more regularly tend to be less prone to depression, fear and anxiety disorders. There is also an important set of suggestions in the literature that walking fosters creativity. It is certainly the case that many creative artists extol the benefits of walking for their subsequent work. Many writers certainly claim this. Walking is a central feature of the creative output of the travel writer and historian of science, Bill Bryson, who has discussed walking in many of his popular books. We know that during walking or locomotion that the activity of a wide variety of brain areas becomes activated and indeed synchronised in time (technically, this is most easily demonstrated in the theta rhythm, which is a predominant feature of brain activity during locomotion). It is not too far of a stretch to suggest that walking, by virtue of its generalised effects on brain function, its activation of widespread and disparate brain areas, and by virtue of its tapping into mechanisms associated with relaxation, is a positive boon to creativity and enhancing subjective well-being.

Redesigning workplaces to facilitate walking and movement more generally should enhance productivity. In a clever recent study, Nisbet and Zelenski (2011) examined the effect of people undertaking walks where they are exposed to nature, versus walking in an enclosed environment. Carleton University, Ontario, is subject to extremes of weather. A substantial fraction of the large campus is connected via a system of extended underground tunnels. They investigated (150 participants; 18–48 years) the effect of walking between two locations on the campus: either through an underground tunnel or over ground past an urban space with trees and other features of the natural environment. Participants underestimated dramatically the likely hedonic benefit of undertaking a 17-minute walk outdoors versus a walk indoors. They also found that the effect of the walk itself on affect, or mood, was very substantial (an improvement in score of one third) relative to individuals who undertook a walk indoors. Thus, activity in an outdoor setting is an important and positive moderating variable on individual mood, independent of its effects on cognition. Walking improves how you feel, but walkers underestimate how much walking in nature is likely to make them feel. The walk along the riverbank with plenty of exposure to nature was rated as much more mood enhancing than the walk through the long, enclosed tunnel. In other words, physical activity outdoors is, to some extent, a simple behavioural antidepressant. Mere exposure, on an intermittent basis, to nature has a strong, sustained effect on mood. Behavioural design measures for buildings and for cities could easily take account of factors like this. It has recently been found, for example, that when controlling for income, socioeconomic status and a whole host of other variables, urban areas that tend to have many trees present and green space available have lesser rates of crime compared with areas that do not.

Learning and Memory: The Basis of Expert Performance

Imagine you are sitting at your desk, thinking about what it is that you have to do. This is an example of ‘prospective memory’, a type of memory focused on remembering your future intentions, rather than the focusing on past acts. Prospective memory includes specific behavioural plans to be implemented. Such plans, ideally, should be written down because, as we are all well aware, plans can be easily and quickly forgotten when the next interruption occurs. As you sit there, an email pops up requesting information on a file on your laptop. You think about this for a moment, and you recall exactly what is required—this is an example of ‘declarative’ memory, a fact or an event that you can recall and state out loud. Next, somebody rings you, calls out their awkward Skype name, which, as you write it down, you can feel it disappearing, but you hold it in your head for a short period of time, perhaps one to two seconds. This is rehearsed through what is sometimes referred to as the ‘phonological loop’, a part of the memory system that is designed to hold short sounds and phrases for very short durations of time. Even with this little thumbnail sketch, it should be apparent that our memory is amazing. To take a slightly different and very prosaic example, if I ask you your name, you can tell me, and you can tell me quickly and rapidly. Yet, you learned your name before you could speak, sometime in the first two or three months after birth, and barring accidents, you will know your name perhaps eight or nine decades later, right up to, or at least close to the point of death. This is a remarkable feat of memory for our brains to perform, particularly given the huge changes that a brain goes through during this period of time. It grows, it develops, it is educated over a very long period of time, it matures, and it also ages. How can a brain do this? And knowing how a brain can do this, can we improve our performance on learning and memory tasks?

We now have some reasonable first principle answers that allow us to explain how a brain can recall like this. But before we explore these, first, take out a sheet of paper, and from memory, try to perform each of the following tasks:

First, think about what is possibly the most famous portrait painting in the world—Leonardo da Vinci's 'Mona Lisa'. Draw a simple rectangle in portrait format, and now try and remember which direction her head faces. Is it to the left as you look at it or is it to the right?

Second, we've all heard of Steve Jobs and Apple computers, which have been a part of personal computing for more than 30 years, and their other products such as the iPhone are ubiquitous. Now, think, how many times have you seen the Apple logo? It must be hundreds, if not thousands of times. Try and sketch the logo from memory, and after you've done that, on a scale of one to ten, rate how confident you are in your recall and how accurate you think your picture is.

Third, you handle money fairly regularly. Think, when was the last time you handled a 20 pound or a 20 euro note? It might have been this morning. Now, describe the note, front and back. Award yourself no points for saying it has the number 20 on it, and it has a currency unit represented on it. What size is it? What colour is it? What images are present on it?

Fourth, like many people, you may have a very regular route to work. Perhaps you take the same train or bus every day, or perhaps you drive the same route every day, something you experience for, say, 30, 45 minutes. Now, think about your commute last Thursday week. Don't look at your diary; just think about the commute. What can you recall about it? Unless something exceptional occurred, you won't recall anything.

Fifth, those who were alive at the time, and old enough, will recall September 11, 2001. Your memory may have faded a bit, but images of that day will pretty readily come to mind. Now, try and recall September 11, 2004. Hard, isn't it? There's nothing distinctive about that day.

Now, go check your answers. You can look up the Mona Lisa and the Apple logo quickly and easily. You may even carry an iPhone, which will allow you to do both of these at once. You can repeat tests like this quickly for many other items that we encounter on a daily basis. How many keys are in your key ring? Most people can't give an exact answer: they give an estimate. How many trees line your road? Again, you'll give an estimate, which is unlikely to be the precise and accurate number, despite the fact that you might have walked past every single one of these trees for the past half-decade or more. The uncertainty you felt doing these tests should be a good reminder of the fallibility of the operations of your own memory.

The key point is: just because something feels familiar, doesn't mean that you've learned anything meaningful about whatever that 'something' is.

Let's take a different example. Can you ride a bicycle? Almost certainly. Most people learn this skill somewhat painfully in their middle childhood years, and with a little practice, perhaps a wobble or two, can resume cycling even after intervals of 10 or 20 years. Now, describe how it is that you cycle a bicycle to somebody else. Not easy, is it? It is more or less useless to say to somebody who has never cycled a bicycle that what you have to do is sit up on the saddle, get yourself into dynamic equilibrium with the environment and apply a force of so many Newtons to the pedals, while stabilising your trajectory with your hands on the handlebars. This is an example of a motor or procedural skill, one that was acquired through practice, and the specifics of which are difficult, if not impossible to describe in words to someone else. Note, this is not the same thing as being able to tell someone else you can cycle a bike. It is the actual doing that is at hand here.

The key point here is this: mere exposure to information does not ensure learning, nor does exposing someone to information change their behaviour. If this were true, that mere exposure to information affected behaviour profoundly, public health campaigns against smoking would meet great success and little resistance. In fact, the formation of new habits can be, especially for adults, very difficult. Lally and colleagues (2010) tracked how long it took for a new health behaviour to become a habit. Examples of a new health behaviour might be doing 50 sit ups after your morning coffee, taking a brisk ten-minute walk directly after breakfast or engaging in 15 minutes of exercise prior to eating dinner in the evening. The authors summarised their study (somewhat dishearteningly) as follows: 'The time it took participants to reach 95% if their asymptote of automaticity ranged from 18 to 254 days.' So, a new habit, one that can promote health, can take up to two-thirds of a year before that habit becomes one that is automatic. One small piece of good news from the study was that missing the new behaviour on the odd occasion did not affect the speed with which the behaviour itself becomes automatic, putting to bed the old idea that interruptions during habit formation can be fatal to new habit formation.

Your Memory: A Brief User's Guide

We now know, after several decades of painstaking research and patience, in normal human volunteers and in animals, the general shape and operating principles of the memory systems of the brain.

Some important introductory points:

First, memory consists of differing types of memory, operating on different timescales and in different brain systems.
Second, damage to differing brain regions causes reliable changes in memory function.
Third, the brain regions involved in 'declarative' or 'explicit' memory are the hippocampal formation and the anterior thalamus; working memory, sometimes referred to as short-term memory, a number of regions in the frontal lobes; and motor, habit and related forms of memory involve brain regions such as the striatum and the cerebellum.
Finally, memory itself results almost certainly from changes in the strength of connections between individual brain cells.

When we consider learning in its most abstract form, we can think of it as occurring in three related phases. The first is *encoding*, the second is *consolidation*, and the third is *retrieval*. Encoding refers to how, for example, marks on a page (letters, words) get somehow translated by cells in the retina and then turned into items, events or behaviours that can be recalled at some other point. The storage of those items, events and behaviours is referred to as consolidation, which is the modification, over short or long scales, of activity within the brain to support memory. Finally, retrieval is the pulling out or accessing of previously learned information. Brown et al. (2014) offer an especially accessible and important treatment of the science of learning and memory, and their book is highly recommended as further reading.

How Well Do You Understand the Operations Underpinning Your Own Memory?

If you watch students trying to learn new material, or watch yourself when you're trying to understand new material, for example, the latest consolidated companies act, or the new regulations that govern the accounting rules and principles for the depreciation of offshore capital investment, you will notice that you underline, highlight and repeatedly reread the passages in question. You may even make notes in those passages, and then you refer to those passages again and you refer to the notes again. In other words, you haven't actually learned the material itself in its totality—what you've actually done is learned where to find the answer to the question that may present itself in the course of your professional work actually is rather than the material itself. This is perfectly reasonable if you are going to be sitting in an office with the time to engage in deliberation and research. It won't work, of course, in a high-pressure environment where answers are required quickly, and the answers themselves must be cogent and to the point. Learners focus on encoding for multiple reasons. It feels active, it feels like you are doing something, the marking of a text with a highlighter or post-its allows you to get some mental map of the text, and it feels somewhat effortful. Learners possibly do this also because they see other learners engaging in this behaviour. The question actually is, do learners have an accurate insight into how it is that they can learn, and are they learning information in a way that allows them to use that information quickly and easily, at some other time? The short answer is no. A focus on encoding is actually not the best way to engage in learning. Marking texts as well as rehearsing the words in that text is a poor learning strategy, especially if you have limited time available. How you go about learning also affects consolidation. Additionally, the rate at which learners attempt to learn new information and the number of interpolated sleep/wake cycles prior to recall have a profound effect on learning itself. Finally, *retrieval* is affected by *lack of retrieval* (that sounds like a paradox, and it is).

Let's explain this a little bit further. Imagine you are learning a new language (a 600-page undergraduate textbook in neuroscience may have an average of five new technical terms on every page. That's 3,000 words to be learned, which is, effectively learning a new language. Now, imagine you are learning a new language such as French or Italian. You will spend most of your time attempting to retrieve the correct words and phrases in the appropriate context while attempting to understand what it is that someone else might be saying to you. Retrieval is actually the key, not encoding, but learners focus on encoding and rarely think about either consolidation or retrieval. Formally, the use of learning strategies that are focused around retrieval rather than encoding is known as 'retrieval practice', and it is probably the most effective or powerful way of actually learning. It involves recalling the test material, or the to-be-learned material, from memory, whether this is words, sentences, ideas, concepts or indeed a sequence of finger movements at a piano key, or the stroke of a golf club. Each act of recall or retrieval causes further elaboration of that memory, through the memory systems of the brain generating further consolidation, in turn making it easier to recall. How many times and in how many places have you had to give your own name when you've been asked for it? Thousands, probably, hence the difficulty of forgetting your own name and the difficulty of learning a new one. On the other hand, much of what we have experienced is evanescent. It disappears, despite the fact that we have experienced it. Think about the last three- or four-hour car journey you have made. You have experienced it, you may have driven the car, you may have used the indicators, you may have used the accelerator, you may have passed somebody out on the motorway, or whatever, but the details are all gone. As Kahneman put it, 'Your experiencing self and your remembering self are strangers to each other'.

How Do You Learn New and Complex Material?

There are a number of principles to use. The first is, after reading through small chunks of the material, write down simple questions and attempt to answer those in bullet-point format, or similarly, before going back to look at the material again. Then, look at it again and correct errors that you may have made in your understanding. Creating very simple quizzes or questions, and testing yourself and attempting to learn by answering those questions, enhances recall dramatically. Repeated bouts of consequence-free questions and answers enhance learning dramatically compared with other methods of learning. Combining this method with another note-taking method that involves not writing out the material that you already just read, but that attempts to understand it conceptually, and elaborates it and relates it to other domains of knowledge that you already have, also enhances learning dramatically and also enhances retrieval of that memory in the appropriate context.

There are other important considerations as well. Imagine you have an important examination next Saturday morning. Should you spend an hour or two per day studying, or should you take Friday off work, stay up all night and attempt to learn all that material for the exam on Saturday morning? The answer should be obvious. A little, often, is much more effectively learned than a lot, infrequently—this is known as the 'spaced practice' effect. Trying to do it all in one go and pulling an 'all-nighter' is a disastrous strategy for at least two reasons: it is not widely appreciated that regular sleep is required for effective learning and memory. Having slept on to be learned material allows you to recall that material much more effectively than would otherwise be the case. Furthermore, sleep deprivation causes degradation in performance on cognitive tasks in direct proportion to the amount of time that you are sleep-deprived. Anyone who has stayed up all night will know this. Anyone who stays up all night repeatedly, or suffers from broken sleep patterns, knows this too, which is why sleep deprivation has been used for generations as a very effective instrument of torture. It is not, however, a useful practice for gathering information.

There are other important means too. If the material to be learned is very complex, for example, if you were learning a complicated and difficult piece of music, a poor strategy is to drill the first section until it is perfect, and then move onto the second section until it is perfect, and then move onto the third section until it is perfect. This actually slows learning and causes a big problem in terms of transitioning from the first section to the second section and from the second section to the third section. A better strategy is to mark the music script up into the appropriate sections and to practice in an interleaved way the different parts, perhaps doing 1, then doing 3, then doing 2, then doing 5 and then doing 1, 2, 3, 4, 5. This is a harder way to learn, but it results in more effective and more efficient consolidation and retrieval of the to-be-learned material.

Learning proceeds best when it is in some sense active, so reflecting upon the to-be-learned material, being able to relate it to other previously learned material, for example, assists in learning. Finally, there are two really important background factors that also enhance learning, which are rarely thought about. The first has already been mentioned above, and that is sleep. Sleep serves a wide variety of important functions, but one of the most important functions is that it allows consolidation of learning that has occurred during the day and the elaboration of that material through semantic networks in the brain. This facilitates the use of that material on the next occasion it is to be recalled. Sleep debt builds up over the course of the day, and sleep, when it is of good quality and sufficient duration, is cognitively clarifying and memory enhancing.

Another factor that is also very important for learning and memory is, remarkably enough, aerobic exercise. Multiple studies in animals and in humans have shown that exercise, as an intervention, has marked and profound effects on all aspects of cognitive function, from speed of mental operations, to attention, to memory. Aerobic exercise causes a wide variety of changes in the brain and the body. It enhances the portal circulation of blood to the brain, bringing nutrients and oxygen; it stimulates the production of various molecules that are important for the functioning of brain cells themselves. These molecules can be thought of as being kind of like a fertiliser for individual brain cells, because they support the growth of connections between individual brain cells. Recent studies by, for example, Griffin et al. (2011), show that acute bouts of exercise to exhaustion after learning, using a bicycle in a gym, enhance the kinds of memory supported by the hippocampal formation, and low-impact regular aerobic exercise in elderly adults can actually slow down the rate at which the brain systems that support learning and memory decline and even support some degree of growth in those brain regions (Erikson et al, Erickson et al. 2011). Humans, frankly, are not built for sitting around for extended periods of time. Our offices and our work environments can and should be designed to allow people to stand up and move around regularly during the course of the working day.

Expertise and Expert Performance

Witnessing somebody performing with a high degree of expertise, for example in a sports game or a musical performance, is intrinsically rewarding. However, learning to be an expert, witnessing somebody's stumbling steps along the road to expertise, is not so interesting or rewarding. Expertise and expert performance rely, in very profound ways, on the scaffolding provided by ample prior learning. The more you learn, the easier it is to learn more, because you have the appropriate conceptual scaffolds present to support more learning. In this section, we will deal with expertise and expert performance, drawing on a wide variety of different examples, from skill in chess, to skill in sports.

Expertise and its Relationship to Learning

Humans have a particular propensity to revere people who are seen in some way to be naturally 'gifted': as they put it in sport, people who are 'a natural'. Furthermore, we prefer to see performances from people who are regarded as having achieved a high level of success as arising naturally from underlying gifts, rather than from hard work. This is a peculiar cognitive bias. Nobody comes into the world able to play the piano, or to write, or to read, or to swing a golf club perfectly or give a TED talk. We know in our hearts and souls that apparent giftedness relies on extensive training, yet we choose to ignore the role that such training, such practice, has, in the display of virtuosity. This is a great pity, because, as the science of learning and memory, and of neuroplasticity, demonstrates across many domains, there are 'critical periods' whereby intensive training and effort can make a substantial difference to long-term performance. It is now clear, for example, that few people are born with 'perfect pitch', the ability to effortlessly, it appears, identify musical notes and place them on a scale, and then reproduce them. Anders Ericsson (2016) suggests that estimates of perfect pitch arise naturally, at about one in 10,000 of the population. However, the frequency of perfect pitch increases substantially in 'tonal languages' (such as Vietnamese) compared with other non-tonal languages. Furthermore, perfect pitch can be trained. It can be learned, but it must be trained somewhere between two and six years, when the auditory cortex of the brain is undergoing dramatic remodelling in response to the inputs that it receives from the environment. In other words, this is a critical period for perfect pitch development. A similar rule applies to polyglots—those who can speak multiple languages.

If you wish to acquire another language, to be bilingual or trilingual, the earlier you are exposed to multiple language communities the better, and the earlier you are exposed, the more unaccented by your native tongue will be the other language that you speak, whereas if such language acquisition is left until the onset of adolescence, accent-free language acquisition is almost impossible. Note here also that the children of immigrants learn to speak the language of the language community that they emigrate to in the accent of that language community, if they arrive into that community prior to about seven or eight years of age—again, another critical period is evident. The overall point here is one that has become ever more strengthened by about a century's worth of work in psychology and neuroscience. Ericsson puts it thus: '…dedicated training that drives changes in the brain (and sometimes depending on the ability in the body) that makes it possible for them to do things that they otherwise could not'. Here, while we like to think that genes make a dramatic difference, in general they do not. They make some contribution, but Ericsson's beautiful phrase 'cognitive adaptability' is at the core of all high-level expert performance. Ericsson puts it thus: '…learning now becomes a way of creating abilities rather than of bringing people to the point where they can take advantage of their innate ones' and 'learning isn't a way of reaching one's potential, but rather a way of developing it'. Here is an important point of contact between the mind-set idea generated by Carol Dweck and the idea of expertise as articulated by Ericsson. Dweck gives us a useful and coherent framework for thinking about how behavioural change is possible. Ericsson gives us a useful and coherent methodology by which to effect that behavioural change, and to do so in a high performance way.

What are the key factors to consider? There are some key factors or issues to consider when attempting to establish expert performance, or to improve performance. The first is to establish a current baseline against which future performance can be measured. This baseline should be realistic, and it should in some way be measurable, even if only in some qualitative sense. Second, when establishing one's own baseline, don't look up except as a guide. You need to look down toward your own baseline and seek to incrementally improve relative to that baseline. There is little point, as a fledgling songwriter, looking at Lennon and McCartney, and thinking 'I can never do that', or worse still, 'With a little bit of effort, I can do that'. The next issue to worry about is that of motivation. The important point to note here is that you need to want to do it, and the reward for doing it, ideally, should be intrinsic—to want to do it for the pleasure of doing it for its own sake. As Mallory, the famous mountaineer, put it when asked about the challenge of climbing Everest, 'Why Everest? Because it is there'. The final point is to ensure that the correct kind of motivated effort and practice are aligned, that the principles governing learning and plasticity are, in turn, aligned with motivation.

How Expertise Is Acquired

So, having got the preliminaries out of the way, the universal rule for acquiring expertise is straightforwardly stated. It is sustained, deliberate and purposeful practice, where you want to improve, and you engage in substantial effort to improve. Further, you use mistakes that you make, deliberately, as error-correcting mechanisms to track down deficits in performance. Sports of all types provide a great example of how expertise can develop across the decades. Marathon runners of 100 years ago, with their bare sub-three-hour performances, are running much more slowly than the performers who now run at very close to two hours. Marathon running is not the only example. A recently invented sport, competitive motocross, provides an example of the extreme compression and extension of performance changes that occur. Compare riders of just 10 years ago to riders of today (use YouTube —there are plenty of videos). The range, variety and complexity of their demonstrated moves are astounding now compared to what seemed to be very slow and not especially complex tricks of 10 years ago. And remember, in competitive motocross, the performers are astride motorbikes weighing several hundred kilos, travelling at anything up to 50 or 100 miles per hour. A different but again related example of expertise change seen across populations is provided by the 'Flynn effect': the steady and near-universal improvement seen in IQ scores across all tested populations, since IQ scores were invented. You shouldn't be overly surprised that IQ scores are improving. We are, as a population, taller and healthier than 100 years ago. During normal skill acquisition, most people will tend to practice until they get to a steady-state level of performance. Their performance is pretty good, but it tends not to improve dramatically beyond this particular point. This habitual level of performance, or automatic level of performance, ensures that you stop learning and stop getting better. There are multiple reasons why this might be so, the simplest of which is that the lower level brain systems (typically subcortical systems) that support automatic performance will not be automatically modulated by the higher level systems (typically cortical systems) that will entrain them. Furthermore, as Ericsson puts it '…automated abilities gradually deteriorate in the absence of efforts to improve'. Focusing on incremental changes to steady-state performance is difficult, but it can be done.

What Is Required for Improved Expertise?

Improved expertise and performance require '*purposeful practice*'. This is practice that has several key characteristics (Ericsson 2016). First, purposeful practice has very clearly and well-defined particular goals for practice. These require some form of benchmarks for performance that can be used as the target to improve. There are many of these. In the case of, for example, a musician, it might be an arpeggio played perfectly; for a computer coder, it might be for an app to be smaller and faster, while not losing any functions; for a sports person, it might be something like a relatively error-free swing of the driver, which places the golf ball in the optimum position to allow a clean shot at the tee. Irrespective of the domain, the key point here is that there is a specific benchmark against which progress toward a very well-defined goal can be measured. Associated with a specific or well-defined goal is a set of actual steps that are required to be performed, which allow you to attain the goal. These can be summarised in a series of questions such as 'How, actually, do you do this? What, actually, do you need to do?' In other words, you must have a plan, and you must be able to measure progress towards that plan. Second, purposeful practice has a particular focus, and ironically enough, focus itself is something that can be improved by deliberate, purposeful practice. To improve, you must give the task concentration, you must give it appropriate attention, and you must be aware that to do so is fatiguing. So you need to practice in order to stretch your limits. Paradoxically, as task performance or expertise becomes more automated, it becomes less fatiguing. Thus, there is a sweet spot where focused, concentrated attention stretches performance, induces some degree of cognitive and physical fatigue, but also results in performance increments. Third, this form of practice involves feedback. The feedback can come from at least two sources. The first is simple self-monitoring, where, having established a particular benchmark, for example, the number of successful backhanders returned to a particular sector on a tennis court, or whatever, and practice is oriented deliberately toward improving that. The other form of feedback can come from a third party, a coach or indeed some form of automated monitoring system, but the key thing here is the feedback needs to be quick and reliable, and it should be ideally close in time to actual performance of the task. Finally, this form of practice should always push you out of your comfort zone. Ericsson is emphatic that this is the key component: that you can't be comfortable with your performance and that you must push the limit of what you can do at that moment, when you are practicing. Sometimes, during practice, it may seem that a particular goal is unattainable. If the goal is reasonable and realistic, then this will not be true. The best approach to adopt is to think of this form of practice as also involving some form of creative problem-solving, where if there is difficulty in skill attainment, and then one should try a different approach, changing direction in order to solve the particular problem at hand. Feedback, when it is positive and constructive, is a great source of maintaining positive motivation.

At its core, expertise, whether in physical, competitive sports or in some form of knowledge working (such as coding), involves particular changes in cognitive and neural structures and functions that allow you to avoid the limits of short-term memory and that allow you to deal with masses of information present in the environment quickly and easily. Again, sports provide a very salient example.

In a typical team sport, evenly matched numbers of players play according to some rule set, with the purpose of driving a ball into or over the opponent's goal line. Conditions change dynamically and quickly on the pitch. The job of the players is to read the changes in the play quickly, so that they can direct their own players to gaps if they are defending or to attack gaps if they are in possession of the ball. Games can turn quickly in a matter of a few seconds at most, and skilled players will be able to read player configurations rapidly, allowing them to anticipate the flow of play. The key word here is patterns. Time and again it has been demonstrated that expert performance relies on the ability to extract patterns quickly and easily from the vast array of information that is presented to us. And these patterns must be extracted or, better still, recognised so that the appropriate systems are activated and the direction of play can be anticipated.

Some have argued (for example, Walsh 2016) that sport performance, and in particular team sport performance, represents among the most demanding of human cognitive activities and that they do so in ways that do not necessarily draw on verbal fluency. Indeed, many highly successful sports performers are unfairly derided as inarticulate by individuals who would, of course, be as physically inarticulate as the players are verbally inarticulate, if placed in the same position. These kinds of widespread changes in the structure and function of the brain are directly observable. The canonical example is the change seen in the brains of London taxi drivers (as discussed earlier). To qualify as a taxi-driver in London, it takes usually between two and five years of practice, learning the many thousands of streets and routes that arise in this ancient and extremely crowded city. The longer taxi drivers spend on the job, the larger, typically, is a specialised part of the brain, known as the hippocampus, which supports spatial memory. These changes are not seen in bus drivers who follow largely unvarying routes, which are pre-prescribed for them. So, simple time behind the wheel is not enough to cause changes in the size of the hippocampal formation.

To summarise, therefore, practice must be purposeful, in other words, oriented toward a goal; it must be deliberate; in other words, it must be focused on measurably attaining that goal; and it must be extended through time. There are no naturals who perform at the highest level without years of hidden graft or effort. Ericsson and others, as has been hinted at above, suggest that the key underlying expertise and expert performance is the development of a novel and extended set of mental representations that allow rapid recognition of patterns, and the application of solutions to those patterns in real time. As they say in the USA, 'Nobody cares about a Monday morning quarterback', or as they say in Ireland, nobody cares about the 'hurler on the ditch'. In both cases, these comments refer to the non-player who has had time to think about the course of play after the game has ended and knows better than the team that played just how they should have played. It is performance during the game that is key, not a sudden insight that arises to a non-participant two or three days later. We have mentioned already how retrieval practice is central to learning and memory. Here, again, retrieval practice manifests itself in a very important and reliable way. The more experience that you have of recalling key patterns and the application of solutions to these patterns in a dynamic context, i.e., in real time, the better will be your performance. You may never attain the word level fluency of a child who learns to speak some other language from the cradle, but testing yourself repeatedly with that language will allow you to move from recognising the meaning of words, to recognising the meaning of whole sentences, rapidly and on the fly (i.e., recognising the underlying patterns) and to retrieve the appropriate words and phrases that allow successful performance to occur.

Exercises

1. When did you last go for a walk? Did you go for a walk with someone? In nature? With your phone in your hand?
2. Think about your office. Can you modify it so that you can spend time standing, rather than sitting, during the day?
3. How is your sleep? Do you get enough quality sleep to ensure that consolidation of learning and memory is facilitated?
4. Do you ensure you get a minimum level of activity during the day? At least a few minutes walking every hour?
5. Think about a complex brief you have to master. Instead of reading and re-reading it, how can you facilitate learning by engaging in retrieval practice? Can you ask someone to quiz you on it?
6. Does Tom Spengler exhibit any appropriate brain hygiene practices? How should he change his brain hygiene regime for the better?

Further Reading

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