Chapter 1
Defining genius

Homer, Leonardo da Vinci, Shakespeare, Mozart, and Tolstoy; Galileo, Newton, Darwin, Curie, and Einstein. What do these world-famous figures in the arts and sciences have in common? – apart from the fact that their achievements are a century or more old. Most of us would probably answer something like this: all ten individuals through their work permanently changed the way that humanity perceived the world: each possessed something we call genius. But pressed to be more precise, we find it remarkably hard to define genius, especially among individuals of our own time.

Despite his fame and influence, Pablo Picasso's stature as a genius is still debated, for example, as is that of Virginia Woolf in literature. In science, Stephen Hawking, although often regarded by the general public as a contemporary genius comparable with Einstein, is not accepted as such by the physicists who fully understand his work; they regard Hawking as only one of several current luminaries in the field of cosmology.

Genius is highly individual and unique, of course, yet it shares a compelling, inevitable quality – for the general public and professionals alike. Darwin's ideas are still required reading for every working biologist; they continue to generate fresh thinking and experiments around the world. So do Einstein's theories

among physicists. Shakespeare's plays and Mozart's melodies and harmonies continue to move people in languages and cultures far removed from their native England and Austria. Contemporary 'geniuses' may come and go, but the idea of genius will not let go of us. Genius is the name we give to a quality of work that transcends fashion, fame, and reputation: the opposite of a period piece. Somehow, genius abolishes both the time and the place of its origin.

The word *genius* has its roots in Roman antiquity; in Latin, *genius* described the tutelary (guardian) spirit of a person, place, institution, and so on, which linked these to the forces of fate and the rhythms of time. Like the Greek *daimon*, the Roman *genius* followed a man from cradle to grave, as expressed in the poet Horace's lines from the 1st century BC defining genius as: 'the companion which rules the star of our birth, the god of human nature, mortal for each individual, varying in countenance, white and black'. Only genius knows, says Horace, why two brothers can differ entirely in personality and lifestyle. But *genius* among the Romans had no necessary relationship with ability or exceptional creativity.

Not until the Enlightenment did genius acquire its distinctly different, chief modern meaning: an individual who demonstrates exceptional intellectual or creative powers, whether inborn or acquired (or both). Homer, despite two millennia of veneration as a divinely inspired poet, did not become a 'genius' until the 18th century. This later usage derives from the Latin *ingenium* (not from *genius*), meaning 'natural disposition', 'innate ability', or 'talent'. It was already in wide currency in 1711, when Joseph Addison published an article on 'Genius' in his newly established journal *The Spectator*. 'There is no character more frequently given to a writer than that of being a genius', wrote Addison.

> I have heard many a little sonneteer called a fine genius. There is not a heroic scribbler in the nation that has not his admirers who

> think him a great genius; and as for your smatterers in tragedy, there is scarce a man among them who is not cried up by one or other for a prodigious genius.

In the middle of the 18th century, Samuel Johnson attempted a definition in his periodical *The Rambler*, which is recognizably modern in its emphasis on genius as being something achievable through dedication. According to Johnson:

> …[S]ince a genius, whatever it be, is like fire in the flint, only to be produced by collision with a proper subject, it is the business of every man to try whether his faculties may not happily cooperate with his desires, and since they whose proficiency he admires, knew their own force only by the event, he needs but engage in the same undertaking, with equal spirit, and may reasonably hope for equal success.

Not long after, Johnson's friend, the painter Joshua Reynolds, noted in his *Discourses on Art* that: 'The highest ambition of every Artist is to be thought a man of Genius.' But in 1826, the critic William Hazlitt suggested in his essay 'Whether genius is conscious of its powers?': 'No really great man ever thought himself so.… He who comes up to his own idea of greatness, must always have had a very low standard of it in his mind.' Picasso, for instance, said publicly: 'When I am alone with myself, I cannot regard myself as an artist. In the strict sense of the word. The great painters were Giotto, Rembrandt, and Goya.'

The scientific study of genius began with the publication in 1869 of *Hereditary Genius: An Inquiry into Its Laws and Consequences* by Darwin's cousin Francis Galton, the founder of psychology, who conducted detailed research on the backgrounds, lives, and achievements of illustrious individuals and their relatives, deceased and living. But strangely, there is hardly a mention of 'genius' in Galton's book; no attempt is made to define genius; and no entry for 'genius' appears in the book's index (unlike

1. ***The Apotheosis of Homer*****, painting by Jean August Dominique Ingres, 1827**

'intelligence'). When Galton published a second edition in 1892, he regretted his title and wished he could change it to *Hereditary Ability*. 'There was not the slightest intention on my part to use the word genius in any technical sense, but merely as expressing an ability that was exceptionally high,' he wrote in a new preface. 'There is much that is indefinite in the application of the word genius. It is applied to many a youth by his contemporaries, but more rarely by biographers, who do not always agree among themselves.'

That unavoidable imprecision persists, despite a somewhat improved understanding of the ingredients of genius and its patterns during the 20th century. 'I have always been wary of attempts to generalize about genius. . . . There seems to be no common denominator except uncommonness', writes the historian Roy Porter in his foreword to *Genius and the Mind*, a collection of academic 'studies of creativity and temperament',

2. Pablo Picasso, 1904. How do we decide which individuals are geniuses, and which are not?

edited by the psychologist Andrew Steptoe, published in 1998. 'And yet, . . . as a historian I cannot help being fascinated by genius.' The imprecision is reflected in the varying stature of those discussed in this book, of whom a mere handful are undisputed

geniuses like Mozart and Einstein. There cannot be a consensus on exactly who is, and is not, a genius. Although certain individuals may be widely accepted as geniuses, the word itself resists precise definition. Indeed, this paradox is part of genius's allure – to academics studying genius almost as much as to Dr Johnson's 'every man'.

The 21st century is perhaps more fascinated by genius even than Galton's Victorian age, when geniuses like the poet Tennyson 'were in full flower', recalled Virginia Woolf, with 'long hair, great black hats, capes, and cloaks'. Geniuses in the arts and sciences – the focus of this book – such as Leonardo and Newton, grip the imagination of generation after generation. So does the military and political genius of Napoleon, Churchill, and Gandhi, and the 'evil genius' of Hitler, Stalin, and Mao. Genius is also a word lavishly applied to top performers in activities as varied as chess, sports, and music. Moreover, the accolade may not only be bestowed but also withdrawn by experts and the public, as the prize-winning and sensationally successful British installation artist Damien Hirst discovered. In response to devastating reviews of his inaugural exhibition of paintings in 2009, Hirst vowed to continue painting and improve. 'I don't believe in genius. I believe in freedom. I think anyone can do it. Anyone can be like Rembrandt', Hirst claimed. 'With practice, you can make great paintings.'

Galton, who coined the phrase 'nature versus nurture', would certainly have disagreed. He was an exceptionally intelligent member of the Darwin family; his maternal grandfather, Erasmus Darwin, was the paternal grandfather of Charles Darwin. It was the publication of his first cousin's book about natural selection, *On the Origin of Species*, in 1859, which persuaded Galton that high intelligence and genius must be inherited. By ranking the abilities of past and present 'men of eminence' – mainly but not exclusively Englishmen – and searching for the occurrence of eminence in families, Galton hoped to prove his thesis, as set out in the opening words of his introductory chapter:

> I propose to show in this book that a man's natural abilities are derived by inheritance, under exactly the same limitations as are the form and physical features of the whole organic world.

To obtain his data on eminence, Galton made the reasonable but problematic assumption that high reputation is an accurate indicator of high ability. He then analysed the records of achievements and honours set out in three printed sources: a leading contemporary biographical handbook, *Men of the Time*; the obituary of the year 1868 published in *The Times* newspaper; and obituaries published in England going back into the past. If he were working today, he would no doubt have analysed lists of Nobel prize-winners, too. On this basis, Galton arbitrarily defined an 'eminent' person as someone who had achieved a position attained by only 250 persons in each million, that is one person in every 4,000. (He argued for this number poetically, since 4,000 is perhaps the number of stars visible to the naked eye on the most brilliant of starlit nights – 'yet we feel it to be an extraordinary distinction to a star to be accounted as the brightest in the sky'.) An 'illustrious' person – much rarer than an eminent one – was one in a million, even one in many millions. 'They are men whom the whole intelligent part of the nation mourns when they die; who have, or deserve to have, a public funeral; and who rank in future ages as historical characters.' As already noted, Galton left a 'genius' undefined.

The bulk of *Hereditary Genius* consists of Galton's attempt to fit his identified 'illustrious' and 'eminent' persons into families. Beginning with a chapter on 'The Judges of England between 1660 and 1865', he moves through chapters on, for example, 'Literary Men', 'Men of Science', 'Musicians', 'Divines', and 'Senior Classics of Cambridge', and concludes with 'Oarsmen' and 'Wrestlers of the North Country'. Clearly, for Galton (as for all subsequent researchers), the idea of genius was meaningful only when applied to a domain, such as a genius for music or a genius for rowing.

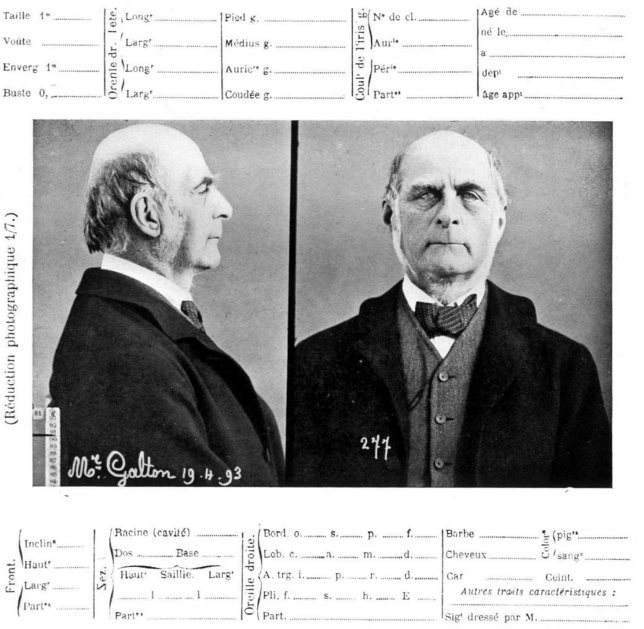
In comparing his results obtained for different domains, Galton claimed that they supported, but did not prove, his hereditarian thesis. 'The general result is, that exactly one-half of the illustrious men have one or more eminent relations.' The highest proportion of the illustrious with an eminent family, 0.8, he found among senior judges (24 out of 30 lord chancellors) and men of science (65 out of 83), the lowest, 0.2–0.3, among divines (33 out of 196) and musicians (26 out of 100), with an overall average for all domains of 0.5. However, Galton admitted that his personal bias could easily have influenced his choice of illustrious and eminent individuals. Among the men of science, he was undoubtedly sufficiently disturbed by Newton's patent lack of intellectual ancestry or descendants to add a lengthy and unconvincing note that attempted to find signs of eminence in Newton's family. Most surprisingly, Galton failed to mention in the book some highly reputed English scientists, including the mathematician George Boole, the chemist John Dalton, the physicist Michael Faraday, the astronomer Edmond Halley, the naturalist John Ray, and the architect Christopher Wren. Faraday, the most celebrated scientist of the Victorian era, was a particularly revealing omission, since, as the son of a humble blacksmith, Faraday and his family could lend no weight to the book's thesis.

Despite Galton's finding of high inherited ability in scientists, a standard biographical study of great mathematicians, *Men of Mathematics* by the mathematician Eric Temple Bell, first published in 1937, shows just how little inherited mathematical ability is, at the highest level of achievement. Some great mathematicians came from lowly backgrounds. Newton was the son of a yeoman farmer; Carl Friedrich Gauss, the son of a gardener; Pierre-Simon Laplace, the son of a parish official and cider merchant. Others came from professional backgrounds. But of the 28 mathematicians of all time described by Bell, beginning with Zeno in the 5th century BC, where ancestral information is available, it shows that there is hardly a trace of mathematical achievement to be found in any of the fathers and close relatives.

Intriguing though Galton's eminent families are, they decidedly do not demonstrate the inheritance of genius. For there is a basic flaw in his analysis: his criteria for genius (which, of course, Galton never defines) are not strict enough, allowing in too many high achievers whose distinction may be considerable but is far from enduringly exceptional. *Hereditary Genius* is, so to speak, closer to the Queen's honours list than the Nobel prize. (Whether or not the Nobel prize is good at distinguishing genius, we shall come to in Chapter 10.) When Galton speaks of the heritability of 'a man's natural abilities' in his thesis, what he really seems to mean is the heritability of talent, rather than genius. As most psychologists now agree, the evidence for some inheritance of talent is considerable, though nowhere near as convincing as Galton claimed, whilst the evidence for inherited genius is slight or non-existent.

Distinguishing talent from genius is inevitably fraught with difficulty, since neither term has a widely agreed definition or method of measurement. The most obvious question to ask is whether talent and genius form a continuum, or are separated by a discontinuity? Put another way, the question becomes: should we speak of greater and lesser geniuses – instead of simply genius? Physicists generally feel that Einstein is a greater genius than, say, his contemporary Niels Bohr (also a Nobel laureate). Artists feel the same about Picasso, as compared with his contemporary Georges Braque. And the same is true for composers regarding Mozart, as compared with his contemporary (and fervent admirer) Joseph Haydn.

Rankings of composers throw some light on this issue. During the 20th century, various rankings were compiled by psychologists, based on asking orchestral players and musicologists to rate lists of composers in order of significance, and also on tabulating the frequency of performance of a composer's work. In 1933, the members of four leading American orchestras were given a list of 17 names of the best-known classical composers, plus the names



Genius

3. Francis Galton, founder of scientific research into genius, posed as a criminal on a visit to the pioneering Criminal Identification Laboratory in Paris, 1893

of two modern popular composers, so as to create a reference point. All four orchestras ranked Beethoven top, at number 1, and the two modern popular composers (Edward MacDowell and Victor Herbert) bottom, at numbers 18 and 19. They also all ranked J. S. Bach, Johannes Brahms, Mozart, Richard Wagner, and Franz Schubert high, and ranked Edvard Grieg, César Franck, Giuseppe Verdi, and Igor Stravinsky low. On average, Brahms was at number 2, Mozart at 3, Wagner at 4, Bach at 5, and Schubert at 6. (Amazingly, George Frederick Handel was not one of the 19 composers on the list.) A similar survey, but this time of 100 composers, answered by members of the American Musicological

Society in 1969, produced similar rankings to the 1933 survey, though now with Bach at number 1, Beethoven at 2, and Mozart still at 3 (and Handel now at 6). Around the same time, 1968, a third survey – this time of performance frequencies – showed Mozart as the most performed composer, followed by Beethoven, then Bach, Wagner, Brahms, and Schubert, in that order. So there are some grounds for thinking that 'Taste is lawful', in the words of the 1969 survey.

But what is perhaps more interesting is the fuller result of the 1933 survey. When each musician was asked to compare each of the 19 composers with each of the rest and indicate his preference, and their rankings were then suitably scaled and plotted on a graph of falling preference against increasing rank number 1–19, the line of the graph was seen to fall gradually from Beethoven to Grieg (before dropping precipitately down to MacDowell and Herbert). The drop in performance frequencies of the 100 composers in the 1968 survey was also gradual, from Mozart at number 1 to Giuseppe Tartini at number 100, without any obvious breaks. An abrupt drop in performance frequency would seem to indicate a discontinuity between genius and talent – but such a drop was not observed.

If talent is a necessary component of genius – necessary, co-extensive, but not sufficient – of what does talent consist? Inherited ability? Passion? Determination? Capacity for hard practice? Responsiveness to coaching? A combination of all of these?

The relationship between inherited ability and long practice is the most contentious aspect of talent. It is very difficult to disentangle genetic from environmental influences. There are seven parent–child pairs of Nobel laureates in science, for example. But it is impossible to determine how much of the success of the child was genetically determined. In addition to having shared genes, William and Lawrence Bragg literally worked together (hence

their joint Nobel prize); Aage Bohr worked for decades at his father Niels Bohr's Institute of Theoretical Physics; while Irène Joliot-Curie was intensively trained by her mother Marie Curie in her laboratory from early on. The fact that there are no parent–child pairs among Nobel laureates in literature (admittedly a much smaller number of individuals than in science), where training is largely solitary, is at least suggestive that training may be more important to success than inherited talent.

Mozart, famously, is a compelling instance of the difficulty. He was the son of a considerable musician: the violinist, music teacher, and composer Leopold Mozart. He also had musical relatives on his mother's side of the family. So he surely inherited some musical ability. But at the same time, he underwent a unique course of training at the hands of his father, a hard driver and an inspired teacher, who controlled Wolfgang's life for over two decades. However, there is a way of separating the effect of the Mozart family genes from the family training which is not normally available. Wolfgang's elder sister Maria Anna, known as Nannerl – four and a half years older than him – who naturally shared half of his genes, was also a talented piano player as a child. She too was exposed to the intensive training of Leopold, side by side with her brother. As soon as the children were ready, Leopold took them on a tour of the courts and major cities of Europe in 1763–6, where together they became celebrities. Yet, Nannerl did not go on to compose, unlike her brother. Why not?

The obvious explanation will not do. Women in the 18th century were permitted to excel in music, if not in many other fields; and several did. And there is no plausible reason why the hugely ambitious Leopold would have chosen to hold Nannerl back during her teenage years in the 1760s, long before the premature death of her mother (after which Nannerl had to act as a companion to her demanding father). 'I suggest the explanation for Nannerl Mozart's lack of progression beyond performance is

that she lacked the capacity for creating original music', writes the psychologist Andrew Steptoe, who has written a major study of Mozart's operas.

> There is a strong case for supposing that the differences between the capacities of the two people who emerged were the product of their personal biological endowments. On the other hand, it is indisputable that without the intense nurturance provided by Leopold, Wolfgang's creativity would not have blossomed.

Mozart's musical ability was transparently obvious to his father (and sister) in childhood, as has been the case with many successful musicians and some composers. This fact has lent credence to the common view – predominant among music educators – that talent is essentially innate: you are born with it and cannot acquire it, though you can (and must) hone it, if you want to make a profession out of it. Thus, people often say that someone they know plays an instrument well because she has innate talent. How do they know she has talent? It's obvious – because she plays so well!

Nonetheless, hundreds of studies by psychologists, conducted over decades, have failed to provide unimpeachable evidence for the existence of innate talent. Although there is certainly evidence of a genetic contribution to intelligence (see Chapter 4), the correlations between general intelligence and various specific abilities – such as playing a musical instrument well – are small. No genes 'for' domain-specific talents have yet been located, although the search continues. Furthermore, the indisputable and astonishing improvement in performance standards observed during the past century, in sports, chess, music, and some other fields, has happened much too fast to be explained by genetic changes, which would require thousands of years. Rather than genes operating alone, psychologists' study of talent suggests the importance of the other factors mentioned above: passion, determination, practice, and coaching.

In one study, young students at a music school were divided into two groups based on the evaluation of their ability by teachers – that is, the teachers' perception of the students' talent. The division was done secretly, so as not to bias the students' future performance. After several years, the highest performance ratings were achieved by those students who had practised the most in the intervening period, irrespective of which 'talent' group their teachers had earlier allotted them to. In another study, by the music psychologist Gary McPherson, children were asked a simple question before they started their first music lesson: 'How long do you think you will play your new instrument?' The options were: through this year, through primary school, through high school, or throughout life. On the basis of their answers, McPherson categorized the children (again in secret) into three groups, showing short-term commitment, medium-term commitment, and long-term commitment. He then measured the amount of practice by each child per week and came up with three more categories: low (20 minutes per week), medium (45 minutes per week), and high (90 minutes per week). When he plotted the children's actual performance on a graph, the differences between the three groups were astonishing. Not only did the long-term committed perform better with a low level of practice than the short-term committed with a high level of practice (presumably forced by their parents!) – the long-term committed performed 400 per cent better than the short-term committed when they, too, adopted a high level of practice.

Recent neuroscientific research offers clear evidence for the physiological effects of determined practice. The brain is plastic, and it alters through practice. One of the best-known studies, published in 2000 by Eleanor Maguire and colleagues, used functional magnetic resonance imaging (fMRI) to examine the hippocampus of London taxi-drivers. Practising their spatial memory assiduously had measurably increased the size of the drivers' hippocampi relative to the hippocampi of a control group. Moreover, the increase in size correlated with the number of years the driver had spent on the job.

Other studies have looked at musicians. One published in 2005 used another MRI technique known as diffusion tensor imaging (DTI), sensitive to changes in white rather than grey matter, to investigate the brains of professional pianists. Its main author, Fredrik Ullén, is a piano virtuoso as well as a neuroscientist, interested in the effect of musical practice on white matter. Myelin, the white fatty substance that sheaths the conducting axons (thread-like nerve fibres) of the adult brain, like plastic insulation around a wire, was found by Ullén to grow gradually thicker with practice, increasing the strength of the DTI signal. The more a pianist practised over time, the thicker was the myelin, the less leaky and more efficient the axons, and the better the communication system of the brain's synapses and neurons.

> Certainly white matter is key to types of learning that require prolonged practice and repetition, as well as extensive integration among greatly separated regions of the cerebral cortex. Children whose brains are still myelinating widely find it much easier to acquire new skills than their grandparents do,

thinks the neuroscientist R. Douglas Fields.

So practice can, it seems, do much to perfect the brain for specific tasks, such as playing the piano, chess, or tennis. But of course the brain initially forms and develops under the direction of an individual's genome, like every other part of the body, uninfluenced by conscious decisions. Which brings us back to the knotty problem of the genetic or innate element in talent.

Since this has, as yet, no solution, the best that can be offered is probably the analysis of two psychologists and a musicologist, Michael Howe, John Sloboda, and Jane Davidson, who together surveyed the entire scientific literature on talent. In 1998, they came to the following cautious conclusions: 'individual differences in some special abilities may indeed have partly genetic origins'; and that 'there do exist some attributes that are possessed by only

a minority of individuals. In this very restricted sense, talent may be said to exist.' Overall, however, they claimed that 'there may be little or no basis for innate giftedness', and that the prevalence of the idea in education (especially music teaching) produces the undesirable effect of discriminating against able children who might otherwise become 'talented' adults. Some psychologists agree with them, but others strongly disagree.

Genius is even more problematic than talent – its definition and measurement still embroiled in the arguments that dogged Galton's *Hereditary Genius*. It would be absurd to deny the existence of genius, faced by the achievements of, say, Leonardo and Newton. But it would be equally absurd to insist that genius has nothing at all to do with 'mere talent', as witness John Bardeen, a double Nobel laureate in physics (the only one) who worked constantly at physics but was not regarded as a genius either by himself or other physicists. Although genius is never inherited or passed on, it seems, like talent, to be partly genetic in origin in many cases, as with Leopold and Wolfgang Mozart, or Erasmus and Charles Darwin. Unlike talent, though, genius is the result of a unique configuration of parental genes and personal circumstances. Since a genius never transmits the full complement of his or her genes – only a half-helping – to offspring, whose personal circumstances inevitably differ from those of the parent genius, this configuration never repeats itself in the offspring. Thus, it is not surprising that genius does not run in families, but that talent sometimes does.