Chapter 6

Is Talent a Myth?

Pure genius is something very, very rare and if you are blessed enough to possess it, you want to think a long time before you walk away from using it.

– Coach Phil Jackson's comments to superstar Michael Jordan on hearing of Jordan's intention to retire from basketball in 1993.

On June 14, 1998, the Chicago Bulls faced the Utah Jazz in the 6th game of the National Basketball finals. More than 35.6 million viewers world-wide tuned in to see what would become the most-watched NBA game in history. The Vivint Smart Home Arena, home of the Utah Jazz, was overflowing with electric expectation as more than 17,000 fans crowded into their seats to watch superstar Michael Jordan model athleticism at its highest level. The Bulls, entering the contest with a 3-games-to-2 lead in a best-4-out-of-7 series, might be within 60 minutes of winning their 6th NBA Championship.

Michael Jordan slam dunks in the 1987-88 season

The Utah Jazz, eager to avenge their loss to the Bulls the previous year, came ready for battle. In a hotly-contested struggle for dominance, both teams engaged in a war of bumps, thumps and trash talking, hidden beneath the graceful leaps, quick-reflex rebounds, and marksman-like shots that brought the audience to the brink of hysteria. After 59 minutes of intense play in which both teams alternately took the lead, Utah had emerged with a lead of 83 to 81–eroding the Bulls' hope for victory as the digital clock counted down the seconds remaining. In a desperate attempt to even the score, Michael Jordan drove to the basket, but was fouled before he could levitate to slam dunk position. When he sunk both free throws, to tie the score 83-83, the audience went wild. Utah stormed back and with only 41.9 seconds remaining, sunk a 3-point field goal giving them an almost certain 86-83 victory. Bulls coach Phil Jackson called a time out to regroup for a final assault. When play resumed, Jordan, taking an inbound pass, drove hard to the basket and slam dunked over the Jazz defenders to reduce the Utah lead to a single point.

The Utah Jazz, taking possession of the ball in their own zone, progressed slowly upcourt to run out the clock and a pass to forward Karl Malone who was heading into the Bull's territory seemed to signal the end. Then, from out of nowhere, Michael materialized from behind Malone, stole the ball and dribbled down the court in a rush that brought 17,000 fans to their feet. As the clock registered 10 seconds remaining, Jordan stopped short, changing pace and throwing Jazz defender Byron Russell off balance. With 5.2 seconds remaining, he executed his famous fade-away jump shot that floated 17 feet through the air and swished through the hoop, winning the game 87-86, and giving the Chicago Bulls their sixth NBA Championship.

Innate Talent or Hard Work?

The spectators, the media, and the players were suspended in disbelief. What they had seen was something that appears only in Hollywood flights of fantasy. It was the confluence of superb athleticism, well-honed skills, and an intensity of purpose housed within an individual. Was there an innate talent underpinning such outstanding performance, or was this a result of intense practice driven by superhuman motivation?

In an article for the Bleacher Report, Dan Favale ranked Michael Jordan as the best player in NBA history explaining:[1]

> *Athleticism, leaping ability, versatility and speed are all criteria for a gifted [basketball] player… His Airness* [Jordan] *is widely considered the greatest player to ever take the court, and he is without a doubt the most gifted athlete the game has ever seen.*

More than 2 decades after Jordan's iconic victory, Rick Morrissey of the *Chicago Sun-Times* opined in an article titled MASSIVE TALENT, NOT STEELY DETERMINATION, FUELED MICHAEL JORDAN'S SUCCESS:[2]

> *For years, I've been bothered by the widely held belief that a large part of Michael Jordan's success was the result of his steel-reinforced willpower and his extreme competitiveness. It's the idea that somehow his desire to win was stronger than anyone else's and, because of it, he became the best basketball player in the world.*
>
> *Jordan's dominance had a lot less to do with his get-up-and-go than his ups. He could jump higher than almost everyone else, and although science says human beings can't levitate, people were able to do their laundry while he hung in the air. Nobody before or after has moved like him on the court.*

However, others insist that Jordan's rise to a level of performance that was head and shoulders above his opponents was *not* a product of innate talent, but rather the result of intense determination and indefatigable practice. Jordan's biographer David Halberstam stated, "If Michael Jordan was some kind of genius, there had been few signs of it when he was young." Halberstam described how Jordan failed to qualify for his high school's varsity team until his junior year.[3] In the first episode of the documentary miniseries, *The Last Dance*, released in 2020, the University of North Carolina's head coach Roy Williams provided insight into the degree of Jordan's motivation. When the eager young player expressed his desire to be the "best basketball player ever to play at UNC," Williams zeroed in:[4]

Williams: You will have to work even harder than you did in high school if you want to achieve that goal.

Jordan: I worked as hard as anyone else on my high school team.

Williams: Excuse me, I thought you wanted to be the best player ever to play here.

Jordan: I'm going to show you. Nobody will ever work as hard as I work.

Indeed, Michael over-performed on his promise. Stories of his unrelenting and gruelling practice sessions in which he challenged his teammates are legion. Applying focus and intensity to his learning he developed skills in jumping, ball handling, and shooting that hadn't been seen before, or perhaps, not even imagined. Certainly, the long hours of deliberate practice were vitally important in the development of these superb skills, but was there some innate talent that was released from the genie's bottle by his extraordinary efforts–or was he an overachiever of average athletic ability?

The Denial of Intellectual Talent in America

In chapter 3, we traced the evolution of the egalitarian ideologies in the former USSR and in America, both asserting that intelligence cannot be inherited. While the USSR acknowledged that individuals differ in intelligence, they attributed these individual differences to environmental factors and not heredity. Trapped between this ideology and the recognition that mathematically talented children were an important resource in the space race of the Cold War, they identified children whom they regarded as gifted in the subject and studied their "gifts" in the hope of discovering instructional techniques that would enhance the mathematical abilities of all.

Meanwhile, many psychologists and educators in America were not only denying the heritability of intelligence, but were going a step further than the former Soviet Union by denying innate differences in individual intelligence. In 1968, educator Benjamin Bloom proposed that "anyone can learn anything," and people differ only in the *rate* at which they learn. Therefore, all students can study the same curriculum, albeit at different rates. It was proposed that any student who failed to achieve mastery of a particular learning outcome could be given additional instruction and then retested, continuing the cycle until mastery was achieved. This approach, later called "mastery learning" flew under several tag lines such as, "Learning is a matter of attitude, not aptitude," and "There are no bad students, only bad teachers." Under the mastery learning philosophy of education, the explanation for failure was transferred from the student's ability to the method of instruction.

A focus on special education increased for students who performed below the average, while programs for the gifted were coming under siege. (By 2012, only four states fully funded their mandates to serve gifted students[5].) Furthermore, the practice of accelerating the gifted by fast tracking them through grades 1 to 12 was criticized as detrimental to their social growth, and "skipping grades", a way of accommodating the fact that children learn at different rates, virtually disappeared. In their discussion of mathematics education in America, Becker and Perl observed[6]:

> *A lively discussion continued to the end of the twentieth century about how (and if) the curriculum should be organized for gifted students. Should it be delivered faster, or in greater depth? Contrary to the situation in other countries such as Hungary, for example, where talented young mathematicians were considered a precious national resource, programs for the talented in the United States were often subject to accusations of elitism and were often nonexistent.*

As the mastery learning philosophy was put into practice, students continued to show wide variances in their ability to learn, no matter what instructional techniques were implemented. Did this difference arise from a difference in motivation or were some students more academically capable than others? The differences observed in the mastery of academic subjects were also manifest in the differences in performance on IQ tests–an observation that Binet and Spearman had made in 1904. However, it was not yet known from research whether these differences were immutable, or whether there were interventions that could bridge the gap.

A Study of Giftedness in Mathematics

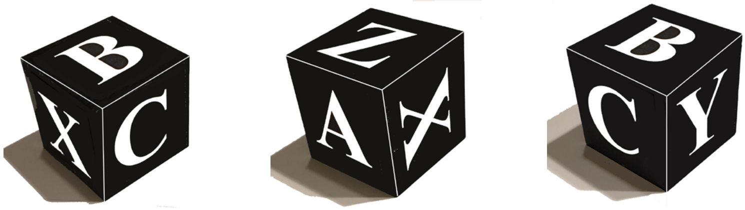
One of the most comprehensive studies of mathematical giftedness was conducted in the Soviet Union between 1955 and 1966, by a team of researchers headed by psychologist Vadim Krutetskii. While the Soviet philosophy embraced the egalitarian *tabula rasa* concept (see chapter 3), rejecting the heritability of intelligence, the team acknowledged that some students are intellectually gifted. Responding to the egalitarian assertion that identifying and instructing gifted students is elitist, Krutetskii, responded:[7]

Some believe that instead of selecting mathematically able pupils we should undertake an investigation of the possibilities for the maximal mathematical development of all pupils. But the one will always complement the other, since even with perfect teaching methods individual differences in mathematical abilities will always occur–some will be more able, others less. Equality will never be achieved in this respect. Consequently, mathematics teachers should work systematically at developing the mathematical abilities of all pupils, at cultivating their interests in and inclinations for mathematics, and at the same time should give special attention to pupils who show above-average abilities in mathematics by organizing special work with them to develop these abilities further.

In his attempts to determine how the mathematically gifted differ from others, Krutetskii and his research team presented a series of mathematics problems to students in grades 6 through 8 (ages 11 to 13) and observed their thinking processes. Once such problem, designed to compare their capabilities in spatial visualization is shown below. You, the reader, might want to try this one before reading the solution.

Problem: Each face of a cube is marked with a letter. The cube is shown in 3 different positions.

Position 1 **Position 2** **Position 3**



Determine the letter on the face opposite:
- the face marked X.
- the face marked A.
- the face marked C.

Solution

Comparing the cube in positions 1 and 3, we see that the letter Y is on the face opposite letter X. Position 1 shows that B is at the top or bottom of X and position 2 shows that A is at the top or bottom of X. Therefore A is on the face opposite B. By elimination, C and Z are on opposite faces. We can also solve this by visualizing rotations about the three axes and picturing the orientations of the letters.

Another measure of mathematical aptitude is the ease with which a student generalizes the solution of a problem involving numbers to the solution of the same problem involving variables. This ability to move from concrete representations to abstract formulations is vitally important as young pupils transition from arithmetic into algebra. One of the problems that Krutetskii and his team used to measure this aptitude is given here.

Problem: A factory is expected to turn out x tools over a definite period, and therefore, planned to make y tools per day. The workers exceeded the quota and each day made z tools more than was planned. How many days before the projected deadline did the plant fill its order?

Any student who was able to solve this problem on first try would be assessed as capable and moved onward to more challenging problems. A student who was unsuccessful, would be given variant 1 of the problem (see below) and on successful completion moved to the next higher variant until ultimately reaching the abstract version given above. The rate at which a student progressed through this sequence from concrete to abstract was used to assess their ability to generalize from specific to general problems.

Variant 1 (numbers only)

A factory is expected to turn out **100** tools over a definite period, and therefore, planned to make **4** tools per day. The workers exceeded the quota and each day made **one** more tool than was planned. How many days before the projected deadline did the plant fill its order?

[Answer: 5 days]

Variant 2 (1 variable)

A factory is expected to turn out $\boldsymbol{x}$ tools over a definite period, and therefore, planned to make **4** tools per day. The workers exceeded the quota and each day made **one** more tool than was planned. How many days before the projected deadline did the plant fill its order?

[Answer: $x/4 - x/5$ days]

Variant 3 (2 variables)

A factory is expected to turn out $\boldsymbol{x}$ tools over a definite period, and therefore, planned to make $\boldsymbol{y}$ tools per day. The workers exceeded the quota and each day made **one** more tool than was planned. How many days before the projected deadline did the plant fill its order?

[Answer: $x/y - x/(y + 1)$ days]

A student moving to the fourth variant, i.e., the original problem, would be expected to discover the answer $x/y - x/(y + z)$.

In describing the results of this research, Krutetskii noted innate differences in the cognitive capacities of children, while carefully sidestepping the Soviet prohibition on linking talent to inheritance[8]:

The difference between capable, average, and incapable pupils, as our research permits us to conclude, comes down to the following. In able pupils these associations can be formed "on the spot"; in this sense they are "born," if one can so express it, already generalized, with a minimal number of exercises. In average pupils these associations are established and reinforced gradually, as a result of a whole series of exercises. They form isolated, concrete associations, related only to a given problem, "on the spot." Through single-type exercises these associations are gradually transformed into generalized associations. In incapable pupils, even the isolated, concrete associations are formed with difficulty, their generalizations are still more difficult, and sometimes such generalizations do not occur at all.

"Geniuses are Made, not Born"

In 1965, while Krutetskii was carrying out his investigation of gifted mathematics students in the Soviet Union, László Polgár, an educational psychologist in Budapest, was attempting to determine the roots of genius. To this end, he studied the biographies of more than 400 of the greatest intellectuals from Socrates to Einstein. In the process, he came to the conclusion that "geniuses are made, not born."

László Polgár in 1969

To test his thesis, he conceived a plan that anyone but an intense scholar might regard as bizarre. He would produce offspring whom he would involve in a prolonged period of intense training and bring them to genius status in some particular intellectual domain. However, this would require a willing mate who would cooperate in the implementation of his plan.

László began sending letters to women who might be interested in sharing his life and assisting in the experiment. Eventually, a Ukrainian teacher of foreign languages, named Klara, responded positively to his solicitation; they were married in the Soviet Union and settled in Budapest. The first of their three daughters, Susan, was born on April 19, 1969. László and Klara home-schooled their children in several languages, in mathematics, and chess, eventually focussing on chess because it was "very objective and easy to measure."

When Susan was 4 years old, László taught her to play chess, and within 6 months she was beating many of the old men who frequented the Budapest chess club. Within a year, she was able to defeat her father and in the years that followed, she won a series of tournaments, reaching Grandmaster status in 1991 at the age of 21.

Sophia, the second born of the 3 sisters, also attained high honors in the chess world, earning the titles of International Master and Woman Grandmaster.

Judit, the youngest of the three sisters, born on July 23, 1976, was introduced to chess around age 5 by her older sister, Susan, who tutored her through her formative years. Though Susan described Judit as a "slow starter, but very hard working," it was soon clear that Judit was destined for greatness. In December 1991, Judit Polgár at age 15 years, 4 months and 28 days, became the youngest person up to that time to achieve Grandmaster status, beating Bobby Fischer's record by a month–marking her 10-year climb to the top. By the end of her active career, in 2014, Judit Polgár was deemed the strongest female chess player of all time, having reached, in 2005, the world ranking of 8th best of all active chess players.

Indeed, László's experiment proved that prolonged practice from an early age can be a major component of high achievement. It also raises some interesting questions. Were the different levels of achievement of the three sisters attributable to innate genetic differences or different environmental conditions, such as birth order or individual motivation? Why were other players able to reach higher rankings in the chess world–was it innate ability, more hours of practice, or more favorable environmental influences?

Is Talent (Giftedness) Merely a Result of Prolonged Deliberate Practice?

In 1993, psychologist Anders Ericsson challenged the concept of innate talent, asserting:[9]

> *Individual differences, even among elite performers, are closely related to assessed amounts of deliberate practice. Many characteristics once believed to reflect innate talent are actually the result of intense practice extended for a minimum of 10 years. Analysis of expert performance provides unique evidence on the potential and limits of extreme environmental adaptation and learning.*

There is no question that years of deliberate practice or intense study are required to perform at the highest levels in sport or academic enterprises. Michael Jordan's prolonged and intense practice was certainly a key factor in his rise to elite performance. Furthermore, the research presented in the previous chapter revealed that in most academic pursuits, a scholar's best work came about 10 years after their first published work. This is easily understood in terms of Cattell's model of crystallized intelligence. While the speed at which a skill can be acquired draws from fluid intelligence, expertise in a particular domain is acquired through practice or study.

However, if outstanding performance is achieved only through a minimum of 10 years of practice, then how do we account for child prodigies like Tiger Woods, who won the Junior World Golf Championship at age 8, or mathematician John von Neumann who could divide two eight-digit numbers in his head at age 6 and was proficient in calculus at age 8? More recently, Terrance Tao mastered arithmetic at age 2 and completed university level mathematics at age 9. How do we explain the prodigy of Mozart who was playing the harpsichord at age 3 and composing a symphony at age 8?

In *Genius Explained*, psychologist Michael Howe states:[10]

By the standards of mature composers, Mozart's early works are not outstanding. The earliest pieces were probably written down by his father, and perhaps improved in the process. Many of Wolfgang's childhood compositions, such as the first seven of his concertos for piano and orchestra, are largely arrangements of works by other composers. Of those concertos that only contain music original to Mozart, the earliest that is now regarded as a masterwork (No. 9, K. 271) was not composed until he was twenty-one: by that time Mozart had already been composing concertos for ten years.

We know from the letters between Wolfgang and his musically accomplished father Leopold, that the senior Mozart was ambitious for his son. It is also possible that Leopold contributed to some of Wolfgang's early compositions. However, the question remains: did Leopold merely encourage the development of a prodigious talent that he saw in his son, or did he "manufacture" a musical genius by driving him to play and compose relentlessly from an early age? Certainly, Mozart couldn't have reached the highest levels of composition evident in his mature works without the many years of immersion in music. Though a long period of deliberate practice is a necessary condition for reaching the highest echelons of achievement in any domain, is it a sufficient condition? Was Mozart's early involvement in music an indication of an innate proclivity for music, or was it a result of early intense exposure–or both?

In his bestselling book *Outliers: The Story of Success*, Macolm Gladwell popularized Ericssons' research asserting that talent is a myth and exceptional performance is merely the result of about 10 years of deliberate practice.[11]

No one has yet found a case in which true world class expertise was accomplished in less time…To become a chess grandmaster also seems to take about 10 years. (Only the legendary Bobby Fischer got to that elite level in less than that amount of time: it took him 9 years.) And what's 10 years? It's roughly how long it takes to put in ten thousand hours of hard practice. Ten thousand hours is the magic number of greatness.

Outliers was published in 2008, and at that time, not only Bobby Fischer, but several others, including Judit Polgár, had reached chess Grandmaster status in significantly less than 10 years. In 1994, Peter Leko became a Grandmaster at the age of 14 years, 4 months and 22 days, having learned chess from his father just before his 7th birthday. In 2003, Sergey Karjakin became the youngest to achieve Grandmaster status at age 12 years and 7 months. He began to play chess at age 5, so it took him only about 7 years to attain that elite status. These shorter periods between learning chess and reaching Grandmaster status suggest that for some, the magic number is significantly less than 10 years. Also, we might inquire why there are differences in the time it takes different individuals to reach eminence and whether the top rung is accessible to all; if not, then what is the factor that makes the difference?

The underlying theme in *Outliers* is that individuals differ little in intelligence and the gap between those who have above average intelligence and those who reach eminence derives mainly from a combination of effort and luck. This is an appealing proposition, not only because we can observe many cases in which it is true, but also because it suggests that most of us are not intellectually inferior to anyone else. Gladwell, asserts:[12]

> *The relationship between success and IQ works only up to a point. Once someone has an IQ of somewhere around 120, having additional IQ points doesn't seem to translate into any measurable real-world advantage.*

This statement is certainly true in many everyday enterprises and professions. From a retail shop owner to a general practitioner in medicine, 30 or more IQ points may not make as much difference as effort or luck. However, we must be careful not to misinterpret this as a statement that anyone of IQ 120 can be a genius if he or she works hard enough. While IQ tests are most effective in comparing the intelligence of those in the IQ range from 70 to 140, they are not designed to measure the kind of extreme intellectual giftedness and creativity that we call *genius*. The fact that differences in IQ at the high end do not make much difference in results merely reflects the limitation of IQ as a measure of the creative dimension of intelligence. Genius in academic pursuits, in particular, requires not only a high IQ, but a powerful combination of intensity, creativity, imagination, and insight that are not accessible merely through luck or extended periods of hard work.

A Challenge to the Dismissal of Talent

In her 2016 book *Grit: The Power of Passion and Perseverance,* psychologist Angela Duckworth, winner of the prestigious MacArthur Fellowship, argues that grit, a unique combination of passion and perseverance, is a vital component of success in any endeavour. However, her research has revealed that talent also plays a role. She states, "Are we all equally talented? No and no. The ability to quickly climb the learning curve of any skill is obviously a good thing, and, like it or not, some of us are better at it than others."[13]

Ellen Winner, psychologist at Boston College, challenges the exclusive attribution of exceptional performance in athletics or intellectual pursuits to prolonged deliberate practice. In her paper on giftedness, she calls attention to child prodigies whose talents emerge before practice is possible:[14]

> *Although Ericsson and his colleagues consider the stories of early (pre-training) achievements of child prodigies to be unreliable, there are simply too many such reports that are too consistent with one another for them to be easily discounted. In addition, these reports come not only from potentially biased parents but also from careful case studies of young prodigies. If exceptional abilities emerge prior to intensive instruction and training, then these abilities are likely to reflect atypical, innate potential.*

In other words, if exceptional performance is entirely attributable to practice that extends over a period of 10 or more years, how do we explain the existence of prodigies who show exceptional performance at an early age before any appreciable amount of instruction is available?

Drawing upon research from MRI scans, Winner states:[15]

> *Indirect evidence indicates that gifted children and savants have atypical brain organization (whether as a result of genetics, the in utero environment, or after-birth trauma). First, giftedness in mathematics, visual arts, and music is associated with superior visual-spatial abilities, and children with mathematical gifts show enhanced brain activity in their right hemisphere when asked to recognize faces, a task known to involve the right hemisphere.*

In September 2004, *Time Magazine* published an article titled, *Saving Smart Kids*, that brought public attention to a research study revealing the importance of accelerating gifted students to grades where they can mix with their intellectual peers rather than their age cohort. The study titled, *A Nation Deceived: How Schools Hold Back America's Brightest Students*, explained how policies against special programs for the gifted, and in particular, acceleration have squandered much of the talent of American children. Sounding the alarm on failed policies, the authors state:[16]

> *Is America ignoring excellence? Newspaper headlines proclaim that our nation's schools are producing weak students who lag behind age-peers in other countries. Meanwhile, there is a quieter story that's been kept in the dark—but is just as important to our country's future.*
>
> *In every state, in every school, in huge cities, and in tiny farm communities, students are ready for much more challenge than the system provides.*

These children perform better than any politician dares to expect. They are the top scorers, the ones who break the curve. They are the kids who read shampoo bottles at age three, and read newspaper editorials at age five. They can add up the cost of groceries faster than a cash register. They shock their parents and wow their grandparents.

But when they enter school, things change. America's school system keeps bright students in line by forcing them to learn in a lock-step manner with their classmates.

Among the reasons given in the study for the political opposition to special treatment of the gifted are "concerns about equity" and "that other students will be offended if one child is accelerated." It would seem that if equity means equal opportunity, then all students should be allowed, and in fact encouraged, to progress at a pace commensurate with their abilities.

Revisiting Insights from the World of Chess

Three-year old Misha Osipov plays chess against Grandmaster Anatoly Karpov

In November 2016, Anatoly Karpov, who reigned as the World Chess Champion from 1993 through 1999, appeared on Russian television in what was billed as a dramatic chess match. His opponent Misha Osipov, an infant of $3^1/2$ years, and barely out of diapers, appeared amidst the sensational pomp and circumstance designed to dramatize his prodigy. When the introductions were over, the blitz game began. (The format of the game was speed chess with Misha allotted a cumulative time limit of 10 minutes, while Karpov was allotted only 2 minutes). Misha charmed the audience with his adult-like behavior. When the 66-year-old Grandmaster asked him what opening he was using, the focussed infant responded nonchalantly, "the Nimzo-Indian Defence." In spite of all the television hype, it was clear that Misha had not only learned how to play chess extremely well, but he had also read books and internalized some of the opening moves of the modern Grandmasters. Though the game appeared to be in a deadlock, Misha's clock ran out first and victory fell to Karpov. Unable to control his disappointment, little Misha wept and ran sobbing to "Mommy." He was, after all, emotionally an infant, performing at a high level in an adult world. When he was called on stage to receive a gold medal, suspended around his neck with a scarlet ribbon and presented with a book autographed by Grandmaster Karpov, he smiled and ran to his mother to celebrate his new trophy and prepare for a brilliant future.

While Misha's performance could easily be dismissed as an over-dramatized media event, the chess prodigy proved his mettle the next year when he defeated Russia's 95-year-old Grandmaster Yuri Averbakh, becoming the youngest player ever to defeat a Grandmaster. There is no question that Misha has a gift that cannot be attributed to 10 years of practice. As chess champion David Hill observed:[17]

> *Both* [Sergey] *Karjakin and* [Magnus] *Carlsen were chess prodigies themselves, and Karjakin holds the record for being the youngest player to become a grandmaster* [at 12 years and 7 months]. *Neither of them could play chess at the age of 3.*

Gifted Children are Different in Some Ways

Those who argue that talent is a myth, dismiss prodigies like Misha, as relatively average children whose ambitious parents have pressed their offspring into early involvement in a particular skill, giving them a head start that puts them out of reach of later competitors. Yet many of those who work with gifted children observe an intrinsic motivation that drives them– even when the parents have tried to discourage their excessive engagement. In their study of the mathematically gifted students, Krutetskii reported.[18]

> *By no means is the early formation of mathematical abilities always related to favorable conditions in the environment and upbringing. In most of the cases we observed, the parents did not create such conditions for their children. On the contrary, when anxious or even alarmed over their children's early development, the parents put obstacles in their way, opposed them, distracted their attention, and in some cases even punished them. It is also important to note that the overwhelming majority of siblings of the mathematically gifted pupils, who were brought up under the same conditions, did not show mathematical ability.*

Such observations suggest that innate talent may be the *cause* of intense dedication to an early obsession rather than the *consequence* of external pressure. Krutetskii observed that mathematically gifted students seemed to be energized rather than fatigued by mathematical activity, while other students tired quickly. Winner provides a description that resonates with descriptions from others who study prodigies.[19]

> *Gifted children have a deep intrinsic motivation to master the domain in which they have high ability and are almost manic in their energy level. Often one cannot tear these children away from activities in their area of giftedness, whether they involve an instrument, a computer, a sketch pad, or a math book. These children have a powerful interest in the domain in which they have high ability, and they can focus so intently on work in this domain that they lose sense of the outside world. They combine an obsessive interest with an ability to learn easily in a given domain.*

How do Gifted Children Perform when they reach Adulthood?

As gifted young people mature from infancy to adulthood, their fluid intelligence, that has been continuously evolving, reaches its peak and then enters a phase of gradual decline. However, their crystallized intelligence, that has also been growing during these years, continues to increase. Many of the gifted eventually become experts in the domain in which their special talent provides a unique advantage. For example, a person who is musically gifted may become a celebrated member of a symphony orchestra or a music critic. A smaller percentage of them–those who are profoundly gifted or exceptionally driven, may become world-class performers or composers. Many of the mathematically gifted will become professors in the natural sciences who conduct research at universities. A small proportion of them will reach what is called *big C creativity* status, and will make significant breakthroughs in their field. Still others will enter private enterprise, and create computer software that expands *deep learning* applications in artificial intelligence.

Polgár's experiment shows us that deliberate practice over a prolonged period, especially when exercised during the formative years, can go a long way toward achieving eminence. And yet the jump from "expert" to "genius" might require an intangible component that we call *innate talent*–the difference that makes the difference among individuals.

The importance of prolonged practice in reaching eminence in a particular domain depends heavily on the cognitive sophistication of that domain. Excellence in a domain like chess is heavily reliant on previous experience, so prolonged practice can go a long way toward closing any differences in talent that may exist between two individuals. However, the kind of thinking that gives birth to a theory like Einstein's General Relativity would seem to be inaccessible to most people no matter how long they were exposed to physics. We observe that none of the other physicists who had the same knowledge base as Einstein was able to make the inferential leap that was Einstein's "spark of genius." The same may be said of the insights of Leonardo da Vinci, Darwin, Mendel, Edison, Tesla, Gödel, Heisenberg, von Neumann, Turing, Feynman, and many others.

Epilog

As curator of the Quora site *Intelligence and IQ*, I receive a large number of questions about intelligence and IQ such as: "Is it possible to increase one's IQ?", "Are Hi-Q people happier?" and "Is EQ (emotional intelligence) more important than IQ?" Questions and responses on this site reveal that people bring a great deal of emotion to the issues discussed in this chapter.

The hotly-contested debate about intelligence in academe further attests to its status as one of our species' most cherished gifts. Some people are willing to accept the existence of talent in athletics or the arts, because these are seen as specific skills, so a lack of talent in these areas is not a major blow to their self-esteem. However, general intelligence, as measured by IQ is such a prized commodity that it is deeply connected to our self-worth. Those who regard themselves as gifted like to believe that their intelligence is innate, making them unique individuals in the sea of humanity. Many others believe that we're all about the same intellectually and differ only in motivation and effort.

Perhaps those who work with gifted children have the best opportunity to observe the unvarnished talent of our species in its earliest stages. Reporting on their research in a *Scientific American* article titled, *Nurturing the Young Genius*, researchers who work with gifted children explain:[20]

> *For nearly a century scholars have sought to understand, measure and explain giftedness. To some, the term is a misnomer for the result of endless practice or social advantage. We believe, however, that extraordinary abilities do exist and do matter. Giftedness implies an ability to perform at the extreme upper end of the distribution in a certain area. Early on it is determined and largely defined by potential, followed by demonstrated achievement and, later, by eminence.*

In the absence of detailed information about our brain's interrelated functions, much of the discussion about high intelligence and giftedness is based on psychometrics. However, advances in brain imaging techniques are beginning to provide insights into individual differences in brain structure and neural processing speed. We observed in chapter 4 that the human brain has a remarkable ability to wire itself to adapt to its environment through a process of neural production and pruning, especially in the early formative years. We saw also that throughout life, the brain can adapt to environmental demands by making new neural connections–a process called *neuroplasticity*.

Dennis Garlick, author of *Intelligence and the Brain,* suggests that differences in intelligence as measured by IQ tests, may derive from different degrees of neuroplasticity among individuals. However, he notes that the mechanism by which the brain rewires itself is still unknown:[21]

> *Is the difference between people of low and high IQ simply based on quantitative differences in the ability to change the connections, or is it that people of differing intelligence actually change their connections based on differing algorithms?*

In the face of evidence suggesting that there are individual differences in intelligence, the California Department of Education in 2021 drafted the *Mathematics Framework for California Public Schools, K-12* document. Rejecting the provision of special programs for the gifted, it asserts:

> *We reject ideas of natural gifts and talents…an important goal of this framework is to replace ideas of innate mathematics 'talent' and 'giftedness' with the recognition that every student is on a growth pathway.*

Once again, in the storied history of intelligence and IQ, ideology has taken precedence over research.

Myth: There is no such thing as innate giftedness in athletics or in scholastics. Anyone with sufficient energy and motivation to invest a minimum of 10 years in deliberate practice can acquire the highest level of proficiency in any skill or intellectual pursuit.

Truth: People differ in their ability to visualize spatial relationships, to form generalizations from specific cases, to solve problems involving quantitative relationships, to draw inferences, and to understand complex concepts.

Furthermore, these differences usually begin to appear early in the formative years, though it is not yet known the extent to which we can change these dimensions of intelligence by early interventions.

Postscript: Yuri Osipov, the father of 3½-year-old Misha, when asked how he felt watching his son sob after losing his chess match to Anatoly Karpov, explained, "He was upset and cried because he was surprised when his clock ran out and didn't understand why he lost. In all previous games of speed chess, he had used a digital clock, but this match used an analog clock–a device that Misha hadn't yet learned how to read.[22]