Chapter 2
Are creators born or made?

The genius view of creativity

In a critically-acclaimed movie about the life and times of Wolfgang Amadeus Mozart, Peter Shaffer painted a vivid picture of this famous Austrian composer. Vulgar, ill-mannered, immature, spoiled and childish, Mozart spent too much time drinking and partying, and he was constantly in debt.

In spite of this corrosive life-style, Mozart produced the most marvelous music, supposedly without even thinking about it. When the time is right and the music starts to flow, Mozart simply writes it down without a second thought.

Antonio Salieri, a well-known composer of Mozart's time, examined the manuscript of this musical genius and discovered no corrections or deletions in it.

Based on this finding, Salieri was convinced that Mozart is an instrument of God. This dramatic portrayal of Mozart as an instrument of God reflects the *genius view of creativity* (Ng, 2007).

At its core is the firm belief that creative geniuses like Mozart are blessed with a special gift or talent which ordinary people like us do not possess.

It is this special gift or talent – often ascribed to God – which enables these eminent creators to produce their creative masterpieces. In contrast, because we do not possess this special gift or talent, we are not creative.

The genius view of creativity has led many people to believe that creativity is more Nature than Nurture, and only certain people like Picasso or Einstein can be creative, because they are born with a good set of genes.

But how true is this perspective on creativity? Are some individuals born to be geniuses while others are fated to be mediocre? Is it possible for an ordinary person without any special talents to transcend the limitations of his or her birth to accomplish a creative feat in life?

What goes into the making of an eminent creator like William Shakespeare or Isaac Newton? What factors shape their psychological development as a creative genius?

In this chapter, I aim to shed light on these questions by looking at the nature and nurture of creativity. I begin by examining the controversy surrounding the gene-genius thesis, and analyzing if creators are born or made.

Then I look at a few developmental factors of creativity, including the creator's family environment, schooling experience and domain of work. Hopefully by perusing this chapter the reader will gain a deep insight on the making of a creator.

The genetic foundation of genius

As we have seen, many people believe, along with the English poet John Dryden, that "genius must be born, and never can be taught".

The first psychologist to subject this genius view of creativity to a systematic investigation is Francis Galton.

In Hereditary Genius, Galton (1869) examined the family pedigrees of eminent creators in a wide range of domains like science, literature, music and painting. He found that creative geniuses were significantly more likely than chance to come from family lines that contained other famous creators.

Galton himself serves as an exemplary instance of this hereditary tendency of genius. To begin with, Galton is a gifted individual who chalked up many creative accomplishments in life.

For example, Galton explored the uncharted realms of Africa, devised the fingerprint scheme that Scotland Yard used to identify criminals, pioneered the development of behavior genetics and created the first psychometric test to gauge natural ability or talent (Simonton, 1998).

At the same time, Galton also hailed from a distinguished pedigree, being the cousin of Charles Darwin, the famous naturalist who developed the theory of evolution by means of natural selection.

Galton's pioneering work on the hereditary origin of genius attracted a number of followers to conduct their own investigation on the genetic foundation of creativity.

One of them was Lewis Terman, who was fascinated with IQ or *intelligence quotient*, especially its relation with creative genius.

IQ is defined as the quotient or ratio of mental to chronological age. Hence if one's chronological age is five but one could solve arithmetic problems done by ten-year-olds, then one's IQ is 200 (ten divided by five times 100). That is, one is twice as smart as one's peers.

Like Galton, Terman (1925) believed that children who displayed high IQ would grow up to become successful adults, even geniuses. To test this thesis, he perfected the Stanford-Binet Intelligence Test.

Terman then used it to identify 1500 elementary school children who were intellectually gifted. He followed these clever children until maturation and published his findings in the multivolume Genetic Studies of Genius.

In this classic work, Terman demonstrated how his precocious children – or "Termites" as they are called – came from homes with intellectually-able parents.

In addition, Terman also showed that these youthful prodigies had, by mid-life, earned impressive reputations for themselves in diverse domains of achievement (Terman & Oden, 1959).

Incidentally, Terman provided a striking proof of this thesis – child prodigies develop into creative geniuses – by gauging the intellectual precocity of Francis Galton. To estimate the IQ of Galton, Terman (1917) examined the personal details of his life.

For example, Galton wrote a letter just before his fifth birthday, in which he waxed eloquent about his reading prowess, his knowledge of Latin, as well as his skills at addition and subtraction. Based on biographical facts like this, Terman estimated Galton's IQ to be just shy of 200, which is the intelligence of geniuses.

Terman's findings on the genetic foundation of genius is supported by the work of Catherine Cox, who was a doctoral candidate supervised by Terman himself.

Employing the biographical technique that Terman had used to estimate the IQ of Galton, Cox applied it to the lives of 301 famous creators and leaders of the past.

To earn a high estimated IQ, Cox's participants had to exhibit skills when young that normally would be found in people much older. For example, a 6-year-old John Stuart Mill could display accomplishments that we would typically expect in an adult, like writing a history of Rome.

Cox (1926) found that most of these eminent individuals had IQ scores in the genius range, with an average estimated IQ about four standard deviations above the population mean.

Sociocultural explanation of genius

The findings of Galton, Terman and Cox on genes and geniuses are not welcomed by many scholars for a variety of reasons. One has to do with the elitist nature of the thesis. That is, only certain people can be geniuses, while the rest of us can only be mediocre.

Another has to do with the eugenical implication of the thesis. Specifically, if genius is born rather than made, then those members of groups who are under-represented in the annals of creative accomplishment are biologically inferior and should be treated as such.

On the other hand, the best-adapted members of the human race (a.k.a. creative geniuses) should be given special incentives to be fruitful, multiply and take over the earth, so to speak.

This sort of thinking paves the way for dangerous ideologies to masquerade as objective science.

Indeed, this was what occurred in war-time Germany. Specifically, the eugenical implication in Galton's Hereditary Genius was developed by the Nazis into a "scientific" theory of racial supremacy.

Eventually, this culminated in the Holocaust where millions of Jews and other minority group members lost their lives because they were not born of the "pure" race of Germans.

The attack on the gene-genius thesis is not slow in coming. It started with the research of Candolle (1873) which focused on the environmental factors that contributed to the emergence of creative genius in the sciences.

Candolle presented data showing that the phenomenon of genius was very much contingent on the economic, political, cultural and social milieu.

Since then, a number of scholars working in various disciplines like anthropology have argued in different ways that creativity is a societal-level rather than individual-level phenomenon. That is, only societies and cultures exhibit creativity, not individuals.

As for the genius with special talents, he or she is nothing more than epiphenomenon arising from seismic shifts in the sociocultural milieu, like smoke billowing from fire.

Two types of evidence are frequently cited to support this sociocultural explanation of genius. One is the phenomenon of multiple discoveries in science. Another is the cultural configuration of genius.

Multiple discoveries in science

The history of science is punctuated with instances of *multiple discoveries*, when two or more individuals arrive at the same finding or idea even though they worked in complete independence of each other.

For example, the calculus was independently developed by Gottfried Leibniz and Isaac Newton; while the theory of evolution by natural selection was separately conceived by Charles Darwin and Alfred Wallace.

Sometimes, these multiple discoveries occur in a simultaneous fashion, which makes them even more dramatic. A famous instance is when Alexander Graham Bell and Elisha Gray showed up at the U.S. Patent Office on the same day to claim legal protection for their respective telephones.

Alfred Kroeber, the eminent American anthropologist, first elaborated on this phenomenon of multiple discoveries in science in 1917. This was the same year that Terman was gauging the IQ of Galton. Kroeber provided a sociocultural account of this phenomenon.

Specifically, for any given culture, the store of knowledge will accumulate as the attention of its members is focused on a pressing problem due to emerging social needs. Consequently, when the time is right certain discoveries or findings become inevitable. This is captured in the saying "necessity is the mother of invention".

Once this creative idea is "in the air", it is up for grabs by anyone. Those who seize upon the idea deserve no credit for it. Instead, so-called creative geniuses are nothing more than conduits for the *Zeitgeist* or "spirit of the times".

To support his argument, Kroeber cited the fact that DeVries, Correns and Tschermak independently discovered Mendel's obscure 1865 paper on genetics in 1900, within a few months of each other.

Kroeber (1917, p.199) remarked that "it was discovered in 1900 because it could have been discovered only then, and because it infallibly must have been discovered then."

From this perspective, the creative genius with his or her special talents can be likened to the ordinary gardener with a fruit basket, waiting patiently to catch the ripe apples or oranges that fall from the tree.

This is a simple analogy to illustrate the point, but some scholars went even further in belittling the relevance of intelligence to the work of genius. For instance, Leslie White (1949, p. 212), another famous anthropologist, said in response to the multiple invention of the steamboat:

> Is great intelligence required to put one and one – a boat and an engine – together? An ape can do this…a consideration of many significant inventions and discoveries does not lead to the conclusion that great ability, native or acquired, is always necessary. On the contrary, many seem to need only mediocre talents at best.

Cultural configuration of genius

Another frequently invoked argument to counter the notion of hereditary genius is based on the idea that creative geniuses tend to cluster into *cultural configurations* (Kroeber, 1944).

Specifically, eminent creators in a certain civilization can be grouped into "Golden Ages" separated by "Dark Ages". For example, in Western civilization, there were many original thinkers during the Golden Age of Greece but fewer in the Dark Ages that followed the break-up of the Roman Empire.

If biological determinists like Galton were correct, then the number of creative geniuses should not drastically alter from one generation to the next. Such rapid fluctuations cannot happen because the gene pool for homo sapiens change slowly, in thousands rather than hundreds of years.

On the other hand, a social learning process, in which each generation of eminent creators provides role models and mentors for the next generation, can account for the cultural fluctuation of genius over time.

This inter-generational effect occurs because the productive period of creative geniuses in a given generation overlaps the developmental period of those in the following generation.

For instance, the youthful Beethoven was reputed to have met the mature Mozart and improvised on the piano for him. In turn, Mozart was so impressed with Beethoven's piano-playing skills that he uttered: "Watch this lad. Some day he will force the world to talk about him."

Supplementary to this main argument is the observation that an eminent creator cannot simply emerge *de novo* or out of nowhere. Instead he or she is always keeping company with other fellow creators.

Indeed to attain the greatest height in a certain field of knowledge, the creative genius must have predecessors to build on. This is captured in a famous saying by Isaac Newton: "If I have seen further than others, it is because I have stood on the shoulders of giants."

No genius, not even Isaac Newton whom some regard as the greatest scientist on this earth, can escape this social dependency on others.

Alfred Kroeber, who emphatically believed that culture rather than biology reigned supreme in any scientific account of behavior, systematically presented this argument in Configuration of Culture Growth.

In this book, Kroeber's goal was to show that the basic thesis of Galton offered in Hereditary Genius is plain wrong. He achieved this goal in a creative way, by directing Galton's methodology against Galton's theory.

Specifically, Kroeber compiled massive lists of eminent creators of the past like Galton. But instead of organizing these notables by family lineages, Kroeber grouped them into cultural configurations of "Golden Ages" versus "Dark Ages". In this way, Kroeber demonstrated that geniuses are made rather than born, instead of the other way round as Galton has argued.

Creators are born and made at the same time

The strong counter-attack by sociocultural theorists on the gene-genius thesis has caused the pendulum to swing 180° to the other end. Consequently, some people may conclude that creative genius is 100% Nurture and 0% Nature.

But this alternative inference based on the notion that "culture is destiny" is as mistaken as the original inference based on the notion that "biology is destiny".

This is because modern behavior genetics has documented a wide array of cognitive and dispositional traits that are subject to genetic inheritance (Bouchard, Lykken, McGue, Segal & Tellegen, 1990).

In turn, many of these heritable attributes are of obvious relevance when doing creative work (Martindale, 1989). Examples include intelligence, perseverance and openness to experience.

The person who carries the genes for such traits is likely to be attracted to original ideas (openness to experience), acquire relevant information in the domain quickly (intelligence) and successfully overcome obstacles in creative problem-solving (perseverance).

Behavior geneticists have also devised powerful statistical methods for partitioning the variability in any individual characteristic into three sources: the genetic, the shared environment as well as the non-shared environment (Bouchard, 1994).

The shared environment includes those things that all siblings have in common, such as the socioeconomic background of their family (well-to-do versus middle-class) and child-rearing practices of their parents (conservative-authoritarian versus liberal-permissive).

The non-shared environment encompasses those things that are unique to each sibling, such as his or her birth order within the family e.g., first-born versus last-born.

The fascinating finding is that for a majority of human traits including creativity, the non-shared environment accounts for much more variance than does the shared environment.

For example, notable scientists were disproportionately first-born children. This finding was first established by Galton (1874) in English Men of Science: Their Nature and Nurture. Since then, it has been replicated many times, for example, by Roe (1953) in The Making of a Scientist.

This surprising finding of behavior geneticists implies that shared environment plays only a small role in (scientific) creativity. However, we should not conclude that nurture has no part in the manifestation of genius.

This is because the sociocultural environment indubitably places definite limits on the scope of natural talents (Simonton, 1978). To appreciate this "sculpting effect" of the environment, consider a female child who is born with a special gift for scientific reasoning e.g., she has a sharp eye for numbers.

This child is not going to realize her innate potential if she grows up in an environment where this type of thinking runs counter to the prevailing sexist dogma that a woman's role in life is to be a home-maker than a scientist.

In my opinion, the most sensible approach to take in this debate between the biological and cultural determinists is to adopt the middle position.

That is, both Nature (genes) and Nurture (sociocultural environment) contribute to the development of creative genius. In short, creators are born *and* made at the same time.

Is genius due to genetic lottery?

In fact, there is some ground to suspect that genius may be due to genetic lottery. To appreciate this line of thinking, we need to understand what *emergenesis* is.

According to behavior geneticists, an emergenetic trait is the result of many independent traits all acting together at the same time (Lykken, McGue, Tellegen & Bouchard, 1992).

If one part of this whole is lacking – one of the traits fail to be biologically transmitted because of a missing set of genes – then the emergenetic trait will not appear.

To give a simple example, for a person to become an eminent creator, he or she must possess the traits for intelligence, motivation and imagination. If one or more of these traits is missing, the person will not become a creative genius.

Emergenesis can explain why a few highly-acclaimed geniuses are devoid of pedigrees. For example, Michelangelo, Beethoven, Shakespeare and Newton are creators of the first rank in their respective domains. But none of these creative luminaries have any distinguished kin.

From the emergenetic perspective, the uniqueness of these first-rank geniuses makes them *sui generis* or one of a kind (Simonton, 1998). To arrive at this rarest-of-the-rare achievement requires a combination of genetic traits which is very improbable.

Consequently, the odds that any person would receive the entire configuration of traits for such creative genius to emerge is practically zero. It is like trying to strike the first prize in a one-in-a-million-chance lottery.

But the continuous and random mixing of the genes that make up the entire human gene pool implies that once in a long while a fortuitous combination may produce the likes of a Michelangelo or Shakespeare.

To conclude, genius may be the result of genetic lottery, and genes may be egalitarian rather than elitist, since every one has a shot at becoming a creative genius regardless of his or her station in life.

Family: The cradle of creativity

Now that we have a good understanding of how Nature and Nurture contribute to creativity, let's examine some of the key factors that are implicated in the making of a creator.

The family is a good place to begin this investigation, as it is the cradle of the eminent creator.

For instance, the fathers of Wolfgang Amadeus Mozart and John Stuart Mill did not sit idly while waiting for their sons to flower as a creative genius. Instead each of them pushed their respective ward hard toward an early and prodigal mastery of the creative domain (music and philosophy respectively).

Indeed, the home environment dominates the infancy and childhood of the typical creator. It continues to exert some influence on him or her all the way through adolescence.

This role of a supportive and stimulating family in the development of creativity has been verified by empirical research. For example, the parents of gifted children and future geniuses usually provide ample opportunities for enrichment (Galton, 1874; Terman, 1925; Roe, 1953; Bloom, 1985).

The creator's parents place a high value on learning and education, which almost invariably takes the form of a home replete with opportunities for intellectual stimulation, such as a large and varied library, ample and diverse magazine subscriptions as well as family outings to museums and galleries.

As a result of growing up in this sort of family, our budding creator displays a deep interest in various fields of knowledge; he or she also has a strong inclination towards omnivorous reading which makes a powerful contribution to creative development (McCurdy, 1960; Walberg, Rasher & Parkerson, 1980).

A rich description of the growing-up years of such creators is provided in a recent article entitled The Early Lives of Highly Creative People: The Influence of the Complex Family.

In this retrospective study on creativity, Gute, Gute, Nakamura and Csikszentmihalyi (2008) conducted a systematic analysis of the recollections of a group of highly creative adults regarding their early family lives.

The nine participants in this exploratory study worked in diverse areas of creativity e.g., literary critic, historian, jazz musician, painter/art educator, sculptor, economist, physicist, playwright/novelist. All of them have made a notable impact on the domain or field in which they work in.

Gute and colleagues conducted face-to-face interviews with these accomplished creators. Then they used the *complex family framework* to organize and interpret this qualitative data.

According to this interpretative framework, a complex family displays *differentiation* (seeking change by constructing a unique identity) and *integration* (working in unison to maintain continuity and stability). Individuals who grow up in such a complex family environment will develop a creative purpose and mission in life.

Gute and colleagues found, as hypothesized, that in spite of the many ways in which their participants differ on particulars, all provide evidence of early family contexts that are differentiated and integrated at the same time.

In terms of differentiation, parents of these creators stimulated new interests and challenges as well as modeled habits of creativity for their children. In terms of integration, these parents supported their children's existing aptitudes and interests and taught them core values and behavioral boundaries.

For example, one of the study respondents was very appreciative of his parents: "They were very generous to me because I showed an aptitude for education, and so they helped me get a lot of education. And also, they helped me to get a kind of grounding in music and literature, and so on and so forth, by their example and their advice, and just by sending me where that was to be found."

Another study respondent described how he picked up habits of discipline by observing his parents: "My father was the most disciplined man I ever saw. And, ah, when he was not with a client . . . I used to go out in the office and be with him. I admired him greatly. When he was not with a client he was studying. At night he was reading or writing…I thought that was what you were supposed to do in the evening…People say, ''Well, I will settle back and look at me some television''; well, I will settle back and do me some writing or some reading, that is just the way that I am."

Conflict and trauma: The pains of growing up

Being born into a stimulating and supportive family which provides for one's intellectual growth is helpful to one's development as a creator. However a happy and idyllic environment which is conducive for learning is not necessarily an ideal condition for the flowering of genius.

On the contrary, to be a creator of the first rank, one must be prepared to endure a certain degree of conflict while growing up (Runco, 1994; Therivel, 1993).

These traumas of maturation come in different forms, like illegitimate birth, parental loss, physical deformity and personal encounter with the total depravity of war.

For example, Leonardo da Vinci was the illegitimate son of a rich young lawyer and a poor peasant girl; Isaac Newton's father died when he was a three-month-old infant; Stephen Hawking lost the use of his limbs to a neuromuscular disease during his adolescence; Victor Frankl was a survivor of the Jewish Holocaust in World War II.

A representative piece of research which showed the impact of early adversity on eminent creativity is provided by Goertzel and Goertzel (1962). These two researchers examined the biographical and autobiographical works of 400 famous individuals who excelled in different spheres of life.

Goertzel and Goertzel (p. xii) found that the majority of their subjects had "in their childhood experienced traumas, deprivations, frustrations and conflicts of the kind commonly thought to predispose one to mental illness or delinquency."

Of the 400 eminent people that they examined, Goertzel and Goertzel (p.131) reported that "only 58 can be said to have experienced what is the stereotyped picture of the supportive, warm, relatively untroubled home…The comfortable and contented do not ordinarily become creative."

The Goertzels also reported on the degree of trauma experienced by different groups of luminaries. All actors in their sample were raised in troubled homes, as were most novelists (89%) as well as composers and musicians (86%).

Explorers and athletes (67%), as well as psychologists, philosophers and religious leaders (61%) experienced an intermediate level of familial conflict. The lowest level of trauma was experienced by inventors who tended to live in peaceful homes (20%).

In a similar vein, Albert and Runco (1987) noted how the early parent-child relationships of eminent physical and biological scientists tended to be "aloof", "not very intense" or "not close".

They suggested that this lack of fit during development can lead to tension in the household of the creator. Albert (1978, p.203-204) used the term *wobble* to describe the conflict-prone family of the eminent creator:

> The creative person-to-be comes from a family that is anything but harmonious – one which has built into its relationships, its organization of roles, and its levels of communication a good deal of tension if not disturbance, what I term a "wobble".

Why is adversity good for creativity?

Many scholars have sought to explain why conflict and tension is so apparent in the lives of eminent creators. One popular interpretation suggests that these traumas help to build the character of the creative genius. Specifically, the pains of growing up enable our future genius to develop an *emotional resilience* that will serve him or her well in adulthood, when he or she confronts the challenges of creative work.

After all, as Simonton (1998, p. 168) observed, "the life of an adult genius is not all wine and roses. It is replete with arbitrary frustrations and unexpected setbacks, misplaced appreciations and unfair attacks."

Different researchers have reported on the "steeling" or toughening effects of difficult experiences. Thus Valiant (1977, p.336) concluded that "the human ego grows in adversity as well as in prosperity."

Rutter (1985, p.600) described how "unpleasant and potentially hazardous events may toughen an individual"; Nietzsche put it more starkly: "That which does not kill me make me strong."

Interestingly, this account of how adversity builds character, which is offered by many scholars in the West, resembles a line of thinking which is engrained in the East. In particular, Mencius, a famous philosopher in Chinese history who is a key disciple of Confucius, has remarked:

> When Heaven is about to confer a great responsibility on a man, it will exercise his mind with suffering, subject his sinews and bones to hard work, expose his body to hunger, put him to poverty, place obstacles in the path of his deeds, so as to stimulate his mind, harden his nature, and improve wherever he is incompetent.

A different but complementary explanation focuses on the *transmission of cultural scripts* – or the basic template of apprehending this world – in the course of growing up (Therivel, 1993).

For ordinary people like you and I who live a normal life, this process flows more or less smoothly, so that we end up with a basic template of life that is not very different from other members within the society.

That is, the good life consists of studying hard, getting a good job, finding a spouse and raising a happy family while making progress in one's chosen profession.

On the other hand, for creative geniuses like Newton and Picasso who undergo traumatic experiences during their early formative years, there is a disruption in the transmission of cultural script. Consequently, they end up with an unconventional and unorthodox template for living.

For example, Isaac Newton's father died when he was a baby. When Isaac was three years old, his mother remarried and went to live with her second husband. She sent her son to live with his grandmother. The young Isaac felt a deep sense of betrayal and never really forgave his mother.

Henceforth, Isaac Newton lost all trust in the subjective world of people, preferring to put his faith in the objective world of mathematics. This unorthodox template for living enabled Newton to become a scientific genius (White, 1997).

As for Pablo Picasso, he was deeply affected by the death of a younger sister. She contracted diphtheria and underwent a painful, highly visible and audible death by gradual asphyxiation.

Young Picasso not only was deeply distraught by this experience, but seemed for some unfathomable reason to have held himself accountable for his sister's death. Speculation had it that the talented artist made a pact with God that he would stop painting in gratitude if his sister's life could be saved (Gardner, 1993).

Since this bargain with the Almighty was not accepted, the deeply superstitious Picasso engaged in a hubristic seizure of power. He felt completely free to do whatever he wanted in his professional and personal life as a creator. This radical template for living enabled Picasso to become an artistic genius.

From this perspective, the unconventional outlook of the creator – which is forged in the trauma of youth – enabled him or her to become a creative genius. But at the same time, it also prevented the creator from leading a wholesome and well-rounded existence.

Gardner (1993) referred to this phenomenon as the *Faustian bargain* of the creator. It is named after Dr Faust, an infamous character in Western literature who sold his soul to the Devil in exchange for knowledge and power.

Gardner argued that the creator of the highest rank is frequently seized by a powerful desire to mould the whole world according to his or her own radical vision. The creator is so caught up in this pursuit that he or she makes many sacrifices, including the possibility of a normal life on earth.

That is, the creative genius, like Dr Faust, pays a high price for the exercise of his or her exceptional talent. The nature of this price varies according to the individual creator.

In the case of Newton, his scientific genius comes at the expense of his relationships with significant others. The adult Newton was a cold, suspicious, paranoid and lonely bachelor who falsely accused his friends of many crimes.

As for Picasso, his artistic genius caused him to develop a misogynic attitude towards women. Picasso categorized the fairer sex into "goddesses" and "doormats", and derived pleasure from tormenting those women who were attracted to his magnetic personality (Huffington, 1988).

"Termites": The dashed hopes of Terman

There is some tantalizing evidence to suggest that these two complementary explanations – adversity builds the character of the creative genius and causes him or her to develop an unorthodox template for living – are on the right track. It has to do with the research participants in Terman's longitudinal study of IQ and creative accomplishment.

Recall that in the 1920s Terman identified a group of intellectually-precocious children and followed them till maturation. Enough time has now passed for us to judge whether these so-called "Termites" with the IQ of a genius lived up to their intellectual potential.

Terman would like us to think so. He dutifully noted that of the gifted males in his sample (who had better career opportunities than the gifted females), 70 earned listings in American Men of Science and 3 were elected to the National Academy of Sciences; 10 had entries in the Directory of American Scholars and 31 appeared in Who's Who in America.

But as Simonton (1994) observed, although these scholarly achievements are noteworthy, they are by no means exemplary. By his calculation, Terman's notable scientists produced on average 20 publications by the time they had reached their mid-40s.

In contrast, American Nobel laureates in the sciences averaged around 50 publications. This amounts to more than a two-fold disparity in output. It also indicates that the "Termites" were not of the same caliber as the true scientific elite.

One of the members of this elite group was William Shockley, who was also among the school children tested by Terman at the inception of his research.

But Shockley's IQ score was not high enough to place him in the genius group. So Shockley never had the distinction of being one of the 857 boys in the Terman group of highly gifted children.

Even without this genius-level IQ, Shockley earned a PhD from the Massachusetts Institute of Technology and went to work for the Bell Telephone Laboratories.

There he invented the transistor which is one of the most crucial developments in the creation of the modern electronics industry. In 1956, Shockley was awarded the Nobel Prize for Physics for this invention.

Based on these findings, Simonton (1998) concluded that the gifted children fell short of Terman's hopes. In explaining why this turned out to be so, Simonton looked at the typical profile of the successful "Termite".

He or she did very well in school, went to a good university, earned his or her advanced degree, and then settled down to a life of writing articles for scholarly journals.

Simonton suggested that the successful "Termite" led an excessively idyllic family life which was too stable, too comfortable, too supportive and too perfect. Such a picture-perfect existence lacks the "wobble" that Albert (1978) believed was crucial for true creativity to emerge.

Simonton's account of why some promising prodigies do not make the cut of creative genius is succinctly expressed by Dylan Thomas, a famous English poet: "There's only one thing that's worse than having an unhappy childhood, and that's having a too-happy childhood."

Dylan spoke from personal experience, as he was a poetic prodigy who grew up in an affluent family with indulgent parents. This idyllic existence failed to toughen him as a creator. So even though Dylan achieved literary fame in his twenties, he was deficient in rudimentary survival skills (Wikipedia, 2009).

Dylan turned to drinking to cope with the stressors of success. This self-therapeutic alcoholism killed Dylan when he was forty. One of Dylan's biographers described this poetic genius as "an overgrown baby who'll destroy every last thing he can get his hands on, including himself."

Born to rebel: Birth order and scientific controversies

Growing up in an enriched environment is good for one's creativity, while experiencing trauma during one's formative years can propel one to the rank of a creative genius. In addition, the birth order that one occupies in the family has an impact on one's development as a creator.

Concerning this issue, we have already seen that being the oldest child in the family augurs well for one's creative accomplishments in life. Specifically, as Galton and Cox discovered, notable scientists were disproportionately first-born children.

Recent research on the link between birth order and eminent creativity has unearthed newer and even more interesting findings. In particular, Frank Sulloway has written a book entitled Born to Rebel: Birth Order, Family Dynamics and Creative Lives.

In this engrossing work, Sulloway (1996) conducted a deep probe into the history of science to understand why some eminent scientists accepted novel theories while other scientists who were equally notable rejected major scientific innovations.

Sulloway's subjects were three thousand participants who were involved in more than two dozen controversies that deeply divided the scientific community. One divisive issue was the Copernican revolution in astronomy which asserted that our earth is not the centre of the universe.

Another was the theory of continental drift proposed by Alfred Wegener, who argued that the separate continents on this planet had once formed a single landmass before breaking apart and drifting to their present location.

Still a third controversy was the Darwinian theory of evolution by natural selection, which asserted that species like homo sapiens are not

immutable or created perfect, but evolved gradually as they adapted to the changing environment.

Sulloway sought to find out if a scientist's birth order predicted his or her stand in the scientific controversy. He discovered that later-born scientists were much quicker to join the scientific avant-garde. By contrast, first-born scientists were more inclined to fight rear-guard actions against the encroachment of new ideas.

These birth-order effects were found even after such potential contaminants like the scientist's age, nationality, socioeconomic class and political and religious beliefs were taken into consideration.

To give an example, the Darwinian theory of evolution by natural selection challenged the religious doctrine that human beings are made in the image of God. This is because it implied that we evolved from two-legged apes roaming the savannas of Africa.

During the heated debate that followed the publication and wide-spread dissemination of this controversial theory, many eminent scientists took opposing stances, like Louis Agassiz (against evolution) and Thomas Henry Huxley (for evolution).

Based on the birth order of the scientist, Sulloway predicted that Agassiz had a 2% chance of supporting Darwin's theory of evolution whereas Huxley had a 98% chance of endorsing it. This is because Agassiz was the first-born in his family while Huxley was the last-born.

Sulloway's prediction hit the nail on the head. Louis Agassiz denounced Darwin's theory as a colossal scientific blunder and spearheaded the opposition to Darwinism in America. By contrast, Thomas Henry Huxley was so enamored of it that he became known as "Darwin's bulldog" in championing the theory of evolution against its dissenters.

There is a familiar ring to this fascinating finding that later-borns are likelier to endorse controversial theories in science compared to first-borns, as radical change is typically perceived to be more acceptable to younger than older people in our society.

But Sulloway goes beyond common sense in adopting a *Darwinian model of family dynamics* to account for this phenomenon. Essentially, children in the family compete with one another to gain a scarce resource, namely, parental love.

First-borns often seek the favor of their parents by acting as a surrogate parent towards their younger siblings. As a result, first-borns tend to identify with their parents, adopt a respectful attitude towards authority and generally support the status quo.

On the other hand, later-borns cannot baby-sit themselves so they look for an unoccupied niche to exploit within the family. One strategy is to cultivate latent talents that can be discovered only through experimentation.

For this reason, later-borns are more exploratory and open to experience; they are also more likely to be skeptical of authority and challenge the status quo. In short, they are born to rebel.

Formal education: Some creators like it while others don't

We have seen that the type of family which the creator is born into (whether it's idyllic or traumatic), as well as the creator's birth order in the family (whether he or she is the oldest or youngest child), have a significant impact on his or her development as a creator (whether he or she becomes a creative genius, joins the rank of the scientific avant-garde and so on).

But the evidence is more equivocal when it comes to the formal education received by the creator. Some geniuses hated school and thought it to be a waste of time.

Albert Einstein is a prime example, and he is especially critical of those schools that stifle the joy of learning:

> It is, in fact, nothing short of a miracle that the modern methods of instruction have not yet entirely strangled the holy curiosity of inquiry; for this delicate little plant, aside from stimulation, stands mainly in need of freedom; without this it goes to wreck and ruin without fail. It is a very grave mistake to think that the enjoyment of seeing and searching can be promoted by means of coercion and a sense of duty.

On the other hand, there are creators who enjoyed school, did well in it and went on to accomplish great things. For example, Marie Curie received a special gold medal when she graduated from the Russian *lycee* at the age of sixteen. She is also the first person in the world to win two Nobel Prizes, for Physics (1903) as well as Chemistry (1911).

Empirically-based inquiries provide a clearer picture of the situation. These studies suggest that the quality of scholastic performance is modestly correlated with adulthood success in some domains a.k.a. the "Termites" of Terman. However, getting good grades as a student is not closely associated with creative accomplishment in later life.

For example, Hudson (1958) scrutinized the undergraduate records of individuals who have been elected as Fellows of the Royal Society, a very prestigious group of scientists where membership is by invitation only.

Hudson found that the academic performance of an F.R.S. was usually undistinguished. Indeed, Isaac Newton was a Past President of the Royal Society who graduated from Cambridge University with only a basic degree.

This lack of correspondence between scholastic achievement and creative accomplishment is especially evident in the artistic sphere of creativity. For instance, D. H. Lawrence is a lauded British writer behind such notorious novels like Lady Chatterley's Lover. But as a student, Lawrence was ranked 13 out of 21 in a secondary school composition class.

Further research has shown that the amount of formal education and achieved eminence as a creator is characterized by an inverted U-shape graph (Simonton, 1999).

That is, formal education first increases one's probability of attaining creative success. But once an optimal point is reached, additional formal education may actually lower one's odds of becoming an eminent creator.

The location of this point varies according to the specific type of creativity. Specifically, for those creators in the arts and humanities, the optimum is reached in the last two years of undergraduate study.

By contrast, for those creators in the hard sciences, the optimum is reached during the first couple of years of graduate school. This finding should not be surprising, considering that there're more facts and figures to amass in the sciences than in the arts.

In the domain of creative writing, for instance, Vera Brittain warned: "The idea that it is necessary to go to a university in order to become a successful writer…is one of those phantasies that surround authorship." (quoted in Simonton, 1999, p.120).

Self-education: Many creators learn by themselves

Mark Twain, the American humorist, once quipped: "I have never let my schooling interfere with my education." As far as eminent creators are concerned, this witty saying rings true.

Indeed, many creative geniuses often dislike school because it interferes with their own learning process. After all, doing formal assignments and mugging for exams do not exactly facilitate one's development as a creator.

Albert Einstein is an example of a creative genius who prefers to educate himself than rely on the formal system of instruction. As an undergraduate, Einstein skipped official lessons in physics to do his own reading in the library (Brian, 1996).

Once, Einstein even dumped a set of instruction on how to conduct an experiment into the rubbish bin. Not surprisingly, Einstein's antics earned him the wrath of the instructor.

Although Einstein is wrong to antagonize his teacher in this way, the fault is not totally his. Some professors in the university did not do a competent job in educating students.

For instance, a professor who taught the history of physics failed to update his course material by incorporating the latest findings in the subject e.g., the innovative theory that light and electricity were different aspects of the same phenomenon.

Einstein was genuinely interested in grasping these new ideas and looked forward to attending the lesson, only to be disappointed as a learner. Can we then blame Einstein for skipping this professor's class to do his own reading on the exciting findings in physics?

Michael Faraday is another example of a self-educated creator (Howes, 1999). In Faraday's case it was the impoverished circumstances of life that pushed him on the path of self-education rather than any inherent dislike of school.

Faraday was born in a very poor family. His father was a blacksmith who was often prevented from working by illness. His mother had been a chambermaid before she married. Faraday had no choice but to leave school at thirteen in order to support his family.

For the next seven years, Faraday worked as an apprentice in a book-binding company. But his situation is not as bleak as it seems. In working as a book-binder, Faraday was able to keep up with his disrupted learning in school by reading up on the latest development in science.

Indeed, Faraday's passion in this field of knowledge was kindled by chancing upon an article on electricity when he was binding the Encyclopaedia Britannica.

Faraday's success in becoming a self-educated creator can also be traced to a kind and understanding employer who allowed workers to engage in their own pursuits, as long as they performed their job.

When Faraday became a famous scientist many years later, he dedicated some volumes of scientific notes to this employer, remarking that "…you kindly interested yourself in the progress I made…readily permitting me to examine those books in your possession that were any way related to the subjects occupying my attention" (quoted in Ng, 2004, p. 96).

Guided education: The special role of mentors

Although many creative geniuses do not like school and quite a few of them are self-taught, it would be misleading to assume that one can scale the peak of creativity by oneself. On the contrary, research has revealed the importance of mentors to the work of the creator.

This crucial role of the mentor is highlighted in a study conducted by Zuckerman (1977), who focused on 94 American scientists who won the Nobel Prize between 1901 and 1972.

Zuckerman found that more than half of her participants had worked under or with other Nobel laureates, either as graduate students, postdoctoral fellows or collaborators.

In interviews with her participants, Zuckerman learned that these Nobel laureates picked up many things from their mentors, including scientific techniques, standards in scientific work, ways of thinking about scientific problems, taste for what constitutes an important problem in science, as well as how the community of scientists operates.

An example of how mentors shape the work of the creative genius can be found in Charles Darwin, the developer of the theory of evolution by means of natural selection. Darwin had many mentors who assisted him in different ways during the course of his creative work (White & Gribbin, 1995).

Robert Grant, a prominent zoologist and radical thinker, was the first of these mentors. Grant opened the eyes of the young Darwin to avant-garde ideas in science, by introducing him to the theory of acquired inheritance which implies that creatures on earth are not created by God.

Another influential mentor is John Henslow, a Professor of Botany at the University of Cambridge, who played a few critical roles in Darwin's evolution as a creative genius.

First, Henslow introduced the young Darwin to Adam Sedgwick, an expert geologist who developed the skills of Darwin as a geologist. Sedgwick mentored Darwin in a very practical way: the two of them mapped out the complex geology of northern Wales during a field trip in summer.

Second, Henslow alerted the young Darwin to the possibility of working as a naturalist in the *HMS Beagle*, which was about to embark on a circumnavigation of the globe.

When Darwin brought up this idea to his father, he met with stiff opposition, as the elder Darwin felt that his wayward son should be looking

for gainful employment instead of wasting his time on a voyage round the world.

Darwin's berth as a naturalist on the *HMS Beagle* was saved by the intervention of his uncle, Josiah Wedgwood, who managed to change the elder Darwin's mind by describing the plus points of the voyage e.g., the young Darwin would learn to be a mature and independent person.

Without this timely intervention of Josiah, Darwin would not have become a naturalist in *HMS Beagle*. He would then fail to see evolution for himself in the Galapagos Islands, namely, birds which evolved contrasting beaks to live in different parts of the island.

In this sense, Josiah can be considered as an "accidental" but important mentor, for he played a crucial role in the evolution of the creative genius of Charles Darwin (Ng, 2004).

Finally, Charles Lyell, who wrote the Principles of Geology, became a key mentor of Charles Darwin in two ways. First, the young Darwin fed his mind on the ideas of Lyell during the voyage of the *HMS Beagle*. Through reading Lyell's book on geology, Darwin gained important insights for his own theory of evolution.

For instance, to explain the great changes that have occurred on earth since its beginning (e.g., the formation of the Himalayan mountain range), we need to rely on nothing more than the natural processes we see on earth today (e.g., earthquakes, climate change, soil erosion).

Second, it was Lyell who personally encouraged Darwin to write a book on the subject of evolution. When The Origin of Species was eventually published, it was described dramatically as "the book that shook the world".

But we can conclude without any reservation that if Charles Darwin had not met and received the help of these mentors, his *magnum opus* would not have seen the light of day.

Development of creative expertise

We have seen that creative geniuses engage in formal education, self-education and guided education. This learning – regardless of its form –

enables the creator to become a formidable expert in a certain domain of knowledge.

Psychologists have tried to shed light on the development of creative expertise. How much knowledge is involved? How long does it take to amass this knowledge? How is it acquired? And so on.

Chase and Simon (1973) had a crack on this problem by studying chess players. They focused on chess because of its well-defined and discrete nature. This enabled the researcher to analyze the memory capacities of different levels of chess players e.g., beginner, intermediate, expert.

We would expect an expert player in chess to possess a superior memory capacity in comparison with amateur players. This expectation is not unreasonable, considering the fact that expert players typically play blind-folded against many chess players simultaneously.

But Chase and Simon arrived at a startling conclusion. Expert players in chess do not differ from ordinary players in terms of memory capacity. They provided a classic demonstration by comparing the memory of three chess players, namely, a grandmaster, a Class A player as well as a beginner.

Chase and Simon briefly exposed these players to chess pieces placed on a chessboard before blocking their vision with a partition. Subsequently, they requested their subjects to reconstruct the exact positions on an empty chessboard.

Sometimes these chess positions were genuine samples of middle-games or end-games that have been played in international chess competitions. Other times the chess pieces were placed randomly on the chessboard by the experimenters.

Chase and Simon found that when the observed positions came from actual play, the grandmaster showed a pronounced superiority in memory compared to the Class A player, who in turn demonstrated a better memory compared to the beginner.

This differential expertise was especially evident for middle-games which contained more pieces in more complex relationships on the chessboard.

In stark contrast, the grandmaster was not any better at remembering the positions of the randomly-placed chess pieces. Indeed, for both middle-games and end-games, the grandmaster put in a slightly poorer performance in comparison with the beginner.

From this study, Chase and Simon concluded that expert chess players do not have a superior memory capacity in comparison with amateur players. However, they were more skilful in making use of their memory to store information on chess positions.

Specifically, the expert player is able to reduce the complexity of a chess configuration to a far more manageable form by *chunking* the chess-related information into meaningful bits and pieces that is easy to recall.

The expert player is able to chunk information in this way because he or she possesses a specialized memory for chess which comes from years of practice e.g., Bobby Fisher, who became a grandmaster when he was fifteen, started to play chess when he was five years old.

Like chess players, creative experts in other fields of knowledge store the relevant information in their domain by chunking it. Chase and Simon estimate that around 50,000 chunks of information are needed for one to become a creative expert in a certain domain.

Concerning the question of how long it takes for genius to hatch, Hayes (1989) conducted studies of musical composers, painters and poets. He found that a period of knowledge acquisition lasting ten years is needed, before creative masterworks are produced.

This finding is evident across creators with diverse artistic orientations, from the 17th to 20th century. For example, seventy-six composers from Harold Schonberg's The Lives of the Great Composers were studied. The date at which each composer began studying music, and the dates of notable creative works (pieces recorded five or more times), were obtained.

Out of more than 500 works, only three were composed before year ten of the composers' careers, and these three works were composed in years eight and nine. Averaged over the whole group, the pattern of career productivity involved one decade of silence before the Big Bang.

Among creativity researchers, this is known as the *ten-year rule of creativity*. That is, on average it takes ten years of hard work for the creative genius to master the knowledge in a particular domain of inquiry, before he or she can produce a unique contribution which is recognized by the world.

Deliberate practice under close supervision

We have seen that to be a creative expert in a certain field of inquiry, one must acquire 50,000 chunks of domain-relevant knowledge over a span of ten years.

Given the obvious amount of hard work involved, it is not surprising that few of us are creative geniuses. As for the outstanding few who achieve this feat, how did they do it?

Ericsson and Charness (1994) have provided us with a good idea of what it takes for a creative person to engage in *exceptional performance* in a certain field. They began with this observation (p.725):

> In nearly every field of human endeavour, the performance of the best practitioners is so…superior even to the performance of other highly experienced individuals in the field, that most people believe a unique, qualitative attribute, commonly called innate talent, must be invoked to account for this highest level of performance.

This view is evident in many domains of expertise, like chess, music, science and the visual arts, where millions of individuals are active but only a very small number reach the highest levels of performance. Despite its popularity, scant evidence supports this talent view of exceptional performance.

For example, research has proven that the superior memory of the expert chess player over the novice, for brief presentations of chess positions, is eliminated when the elements of the same stimuli are presented in a randomly-arranged format (Chase & Simon, 1973).

Ericsson and Charness termed this phenomenon as the *domain specificity of expert performance*. They argued that experts have acquired their superior performance in a particular domain by engaging in deliberate practice.

Deliberate practice refers to an individualized training program selected by a qualified teacher, which is aimed at the goal of improving the practitioner's performance in the domain.

Deliberate practice is different from both play and work. Unlike play, deliberate practice is not inherently motivating; unlike work, it does not lead to immediate social and monetary rewards.

As an example of deliberate practice, advanced chess players spend as many as four hours a day studying published games between international chess masters.

The effective component in this study is predicting the chess master's next move without looking ahead. If the prediction is wrong, the advanced player examines the chess position more deeply to identify the reasons for the grandmaster's move.

This extended evaluation of chess games improves the ability of the advanced player to internally represent chess positions of played games i.e., he or she becomes good at chunking.

How much time must a person spend on deliberate practice before he or she can become an expert performer with around 50,000 chunks of domain-relevant information at his or her command?

To find out this answer, Ericsson, Krampe and Tesch-Romer (1993) compared the starting ages and amount of weekly practice for international, national and regional-level performers in many different domains.

Ericsson and colleagues found that performers who reached higher levels tended to start practising as many as from two to five years earlier than did their less accomplished counterparts.

Performers who attained higher levels of performance spent more time on deliberate practice than did less accomplished performers, even when there was no difference in the total time both groups spent on domain-related activities.

By the time performers approach their middle to late teens and are applying for scholarships and admission to the studios of master teachers

and the best training environments, large differences in deliberate practice and acquired expertise are already present.

For instance, by age twenty, top-level violinists have practiced an average of more than 10,000 hours, approximately 2,500 hours more than the next most accomplished group of expert violinists, and 5,000 hours more than the group who performed at the lowest level.

Deliberate practice in these domains is not inherently enjoyable, yet many individuals still engage in it. How did they end up in this torturous regime? According to Bloom (1985), international-level performers start out as children by engaging in playful activities in the domain.

After a period of playful and enjoyable experience these individuals reveal "talent" or "promise". At this phase parents typically encourage their children to engage in limited amounts of deliberate practice, as well as to take lessons from a teacher.

The next phase is an extended period of preparation – as long as ten years or more – and ends with the individual's commitment to pursue (or not to pursue) activities in the domain on a full-time basis.

During this period, the daily amount of deliberate practice is increased, and advanced teachers and training facilities are sought out. Occasionally parents may even move to a different region of the country to provide their children with the best possible training environment.

Mirroring the findings of Zuckerman in her study on Nobel Prize winners, Bloom found that nearly all of the individuals who ultimately reached an international level of performance worked with master mentors who had either reached that level or had previously trained other individuals to that level.

Albert Einstein: The making of a creative genius

To seal our understanding of how creative geniuses are shaped by their social environment – family, school, community – we need to examine one final piece that completes this jigsaw puzzle. I refer to the question of how creative geniuses gain recognition for their innovative insight.

Csikszentmihalyi (1999) has shed light on this issue through his *systems perspective on creativity*, in which he argues that creativity is a social phenomenon which arises from the interaction of three components, namely, the creator, the domain and the field of gatekeepers.

The *creator* conducts his or her inquiry in a certain *domain* which consists of symbolic rules, procedures, facts, findings and so on. As we have seen, the creator takes a lot of time and pain to master the relevant knowledge in the domain a.k.a. the ten-year-rule of creativity, deliberate practice under close supervision and so on.

Eventually, the creator comes up with an original way of restructuring the available knowledge in the domain. For instance, species on earth have evolved by natural selection instead of being created by God. Or the sun rather than the earth is the center of this universe.

Whatever the creative insight may be, it will be scrutinized carefully by the *field* in which the creator works in. The field consists of a variety of *gatekeepers* who play a crucial role in establishing and maintaining disciplinary standards i.e., what constitutes a creative product, an original idea, an innovative solution and so on.

These gatekeepers vary across domains of creativity. For example, they could be experts working in the same area as the creator e.g., the scientific community.

Or independent reviewers who critique the work of the creator e.g., art or literary critics. Or even the consumer of the creative product e.g., cinema-goers who flock to watch a critically-acclaimed movie and enable it to become a box-office hit.

Without the endorsement of these gatekeepers – the "who's who of the field" – the original idea or innovative product will not be widely accepted. Nor will the creator gain recognition for his or her work.

Using this systems perspective on creativity, we can understand how Albert Einstein became a creative genius (Ng, 2001, 2007). As a creator working in the domain of theoretical physics, Einstein spent a lot of time in acquiring the relevant knowledge e.g., Newton's law of gravitation, Faraday's research on electricity, Maxwell's equation on electromagnetism and so on.

At that time, a central problem in theoretical physics was the elusive nature of the ether. Newton had postulated this mysterious entity to account for the gravitational effects which enabled the planets to revolve round the sun.

But scientists through the ages have puzzled over what the ether is. After pondering on this problem for a long time, Einstein came up with the theory of relativity, a brilliant solution which accounts for gravitation in the physical universe without the need to invoke the elusive ether of Newton.

Although Einstein has devised an innovative way to restructure the available knowledge in the domain, for his theory to become widely accepted by the scientific community, it must first be endorsed by the gatekeepers in theoretical physics.

The theory of relativity states that a massive object in the universe, like the Sun for instance, would warp the space around it. If what Einstein theorizes is correct, than starlight should bend as it passed by the Sun. This bending of starlight could be captured on photo during a solar eclipse.

A team of gatekeepers in the field, led by Sir Arthur Eddington, a famous British astronomer, attempted to verify Einstein's theory of relativity, during a solar eclipse on 29 May, 1919.

Eddington and his colleagues photographed the positions of several stars during the solar eclipse, which lay in the same direction in the sky as the Sun.

When they processed these photos, they found that starlight was bent as it passed by the Sun, as predicted by the theory of relativity which Einstein has developed.

Eddington made an official announcement of his team's findings during a special gathering of distinguished scientists in London. With the stamp of approval from these gatekeepers, Einstein gained recognition as the successor of Newton by solving a centuries-old puzzle in science.

The presence of the media in this august gathering of scientists ensured that Einstein would become a household name all over the world, even though the reporters provided an incoherent description of his theory.

Summary

In this chapter, we examined the Nature-Nurture controversy in creativity. That is, are creators born or made?

Proponents of this thesis argue, in accordance with the genius view of creativity, that only certain people like Picasso or Einstein can be creative, because they are born with a good set of genes.

On the other hand, opponents of this thesis argue that only societies and cultures exhibit creativity, not individuals.

A sensible approach to take in this debate between the biological and cultural determinists is to adopt the middle position. That is, creators are born and made at the same time.

Subsequently, we examined the key factors that contributed to the development of the creative genius. One crucial factor is the extent to which the family provides a supportive and stimulating environment for the budding creator.

But a happy and idyllic environment is not an ideal condition for the flowering of genius. On the contrary, creative geniuses experienced a significant degree of conflict while growing up.

Another crucial factor is the birth order which the creator occupies in the family. Specifically, later-born scientists were much quicker to embrace controversial theories in science compared to first-born scientists.

A third crucial factor is the role of education. Whereas some creators loved to go to school and did well in their studies, others hated formal schooling and preferred to learn by themselves.

Whether the creative genius engaged in formal education or self-education, he or she is not likely to scale the peak of creativity alone. On the contrary, guided education or mentors played an important role in the work of the creator.

Psychologists estimate that the typical creator possesses around 50,000 chunks of domain-relevant knowledge which he or she acquires over a span of ten years in sequential phases.

In the initial phase, the creator shows promise or talent while engaging in playful and enjoyable activities in the domain. In the subsequent phase, the creator engages in an intense period of deliberate practice under close supervision by master mentors.

In mastering the available knowledge in the domain, the creator comes up with an original way of restructuring it. His or her innovative theory or insight is recognized by gatekeepers in the field as being first-rate or path-breaking. This recognition by the field enables the creator to be hailed as a genius by the rest of the world.