

1 What Makes Us Creative?

Over two thousand years ago, Plato, in *Meno*, pondered the origins of new knowledge, how new concepts can emerge from those already established in the brain: How can a system produce results that go far beyond the material it has to work with? This is the problem of creativity.

Let's start with a working definition that I've arrived at from many years' study of creativity: Creativity is the production of new knowledge from already existing knowledge and is accomplished by problem solving.

In the case of scientists, it is obvious that what they are doing is solving problems. Why is the universe as it is? What keeps us on this planet? Why do we not all fly off into space? Where do we come from, and why do we look a lot like apes? These are problems that we have puzzled over for millennia. To work on them, thinkers through the ages have built on the knowledge accumulated by great minds of the past and pushed it forward, extending the boundaries of what we know.

In recent years, the problems have become more focused, more sophisticated: Can we understand how species evolve? Can we identify the building blocks of life? How can we unify quantum physics with gravity? How can we connect computers with each other?

Engineers also solve problems: how to make a bridge or a building or a mighty cathedral in such a way that it will not fall down; what electricity is and how to harness it.

Like scientists, artists, writers, and musicians build on knowledge built up over the centuries. They all begin by working within rules, though they may choose to break them. The knotty problem that Picasso put his mind and genius to was how to reduce the forms we see around us, the natural world of people and places, to geometry. He began by working within the

rules of postimpressionism, then broke those rules to produce images showing all perspectives at once, from which emerged cubism.

Writers need a subject. Dramatists and poets like Shakespeare and Wordsworth confronted problems like how to tell a story or evoke a scene or a feeling within the constraints of language and of the literary traditions of their day. The constraints of the sonnet form, for example, or of iambic pentameter in themselves can spark creativity. Searching for a rhyme can set the imagination roving in new directions.

In fact, constraints—problems—are what spur the creative act itself. A writer needs a subject. You don't just decide to write; you need to have a subject, something to write about, and that itself is the first problem. A novelist will confront multiple problems: what sort of plot to use, who the characters are, where the climax is. Writers too may work within the framework of a particular set of rules, then break out, as Apollinaire, Gertrude Stein, and the Beat poets did.

Composers have to follow the rules of composition and may then break them, as Beethoven, Eric Satie, Igor Stravinsky, Philip Glass, and Steve Reich did. They all broke traditional rules and came up with new ones. This is how artistic forms move forward as one movement supersedes another.

The definition of creativity as the production of new knowledge from already existing knowledge, accomplished by problem solving, applies equally to the brain as an information-processing system and to the computer. It takes into account both the final product and the process of producing it.

For us, thinking consists of receiving perceptions that the brain acts on and uses to create new knowledge. Similarly, the computer is fed data, which it processes and uses to generate, for example, art, literature, or music.

But what are the means by which the brain and the computer process information? Neither we nor a computer are born with a completely clean slate, a *tabula rasa*. There must be at least the potential to create knowledge. There have to be concepts of some sort that are innate, hardwired in.

To return to our definition: Every day we come up against situations that we deal with by turning them into problems, from drawing up a shopping list to studying the Middle East quandary to exploring string theory in physics to painting, composing, and writing. To start with, we need to distinguish between everyday creativity, like discovering a different route to work—little-c creativity—and the big domain-breaking feats of creativity, such as discovering the theory of relativity—big-C Creativity.

Einstein, Bach, Picasso: What Makes These People Special?

Some people are born with extraordinary creative facilities and have a command of a subject that cannot be obtained merely by hard work. We often call them geniuses. Although we cannot duplicate their creative feats, we can learn from the way they think, thereby increasing our own creativity.

The world of the intellect is not a level playing field. For most of us, no matter how diligently we paint, practice music, ponder science, or write literature, we will never be Picasso, Bach, Einstein, or Shakespeare. Some people are simply smarter than others. And even then, it is a matter of time and place that determines whether budding geniuses will be able to grow and flourish and achieve their potential.

People of such caliber spring up without warning, and it usually has little to do with heredity. Few geniuses had families with extraordinary mental attributes. Einstein's father ran a succession of unsuccessful companies that manufactured electrical apparatuses, and Picasso's father was a low-level artist. Bach came from a family of highly competent musicians, but they produced no notable works. Nor is there any correlation between a high score on an IQ test and genius. Richard Feynman, the suave, eminently quotable, and iconoclastic physics genius who made key contributions to working out how electrons interact with light, was reported to have had an IQ of 125—high but not exceptional—and Poincaré, himself interested in the nature of creativity, scored very low on an early version of the Binet-Simon Intelligence Scale, a forerunner of the modern IQ test.

Over the course of many years' study, I've examined the lives of many geniuses and high achievers in great detail: towering figures such as Einstein, Poincaré, Picasso, Georges Braque, Erik Satie, Philip Glass, Subrahmanyan Chandrasekhar, Arthur Stanley Eddington, Wolfgang Pauli, Werner Heisenberg, Niels Bohr, Carl Jung, Gustav Mahler, and Bach. In the twenty-first century, there is a new sort of genius, too, people who dream up ideas for tech start-ups that dramatically change our view of the world and our relationship to it. These include Jeff Bezos, who created Amazon; Sergey Brin and Larry Page, whose search engine was the basis for Google; Bill Gates and Paul Allen, who standardized personal computers with MS-DOS; Steve Jobs and Steve Wozniak, who began Apple; Demis Hassabis, Shane Legg, and Mustafa Suleyman, whose great idea was DeepMind; Peter Thiel, the venture capitalist who invented PayPal; Elon Musk, who pioneered Tesla and SpaceX; and Mark Zuckerberg, founder of Facebook.

From my studies of these people's lives, seven hallmarks of big-C Creativity emerge:

- The need for introspection
- The need to know your strengths
- The need to focus, persevere, and not be afraid to make mistakes
- The need for collaboration and competition
- The need to beg, borrow, or steal great ideas
- The need to thrive on ambiguity
- The need for experience and suffering

I have also identified two marks of genius that cannot be taught:

- The ability to discover the key problem
- The ability to spot connections

In the next chapter we will look at each of these in detail.

Geniuses, as well as most high-caliber thinkers, can be self-inspired as well as self-starters, always working on something new, always thinking up their own problems. They sometimes accomplish their intellectual achievements under physical conditions that would drive most others to despair: working in unheated ateliers, taking an uninspiring nine-to-five job, working heavy production schedules to make a living, or turning ideas spawned in garages into marketable items.

Einstein worked as a clerk in a patent office—a job he obtained through a friend's father—for eight hours a day, six days a week. Suffering poor reviews and huge losses on his operas, Philip Glass took jobs as a mover, plumber, and taxi driver while continuing to compose. "I have a wonderful gene," he wrote, "the I-don't-care-what-you-think gene."³ As a young man in Paris, Picasso stole milk from neighbors' doorsteps. Bill Gates and Paul Allen and Steve Jobs and Steve Wozniak gave new meaning to the term "garage workshops." These people turned inward into themselves, doing what they had to do to survive in order to find their Holy Grail: to create. As Picasso put it, "The important thing is to create. Nothing else matters; creation is all."⁴

Their stories are hugely inspirational.

What went on in the brain of a Picasso, a Bach, or an Einstein—or a Steve Jobs? That is the first question this book sets out to explore.