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Dean Keith Simonton ⋮⋮ 10/31/2012

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The Science of Genius

Outstanding creativity in all domains may stem from shared attributes and a common process of discovery

By Dean Keith Simonton

Identifying genius is a dicey venture. Consider, for example, this ranking of “The Top 10 Geniuses” I recently stumbled across on Listverse.com. From first to last place, here are the honorees: Johann Wolfgang von Goethe, Leonardo da Vinci, Emanuel Swedenborg, Gottfried Wilhelm von Leibniz, John Stuart Mill, Blaise Pascal, Ludwig Wittgenstein, Bobby Fischer, Galileo Galilei and Madame De Staël.

What about Albert Einstein instead of Swedenborg? Some of the living might also deserve this appellation—Stephen Hawking comes to mind. A female genius or two might make the cut, perhaps Marie Curie or Toni Morrison. And if a chess champion, Fischer, is deemed worthy, other geniuses outside the arts and sciences ought to deserve consideration—Napoleon Bonaparte as a military genius, Nelson Mandela as a political genius or Bill Gates as an entrepreneurial genius, to name a few candidates.

All these questions and their potential answers can make for some lively cocktail party conversations. What they reveal is how little we understand about the origins of intellectual and creative eminence. Explorations of this age-old debate have long sought to tease out the common features of geniuses working in disparate domains. The existence of unifying threads—including genetic factors, unusually broad interests and a link with psychopathy—suggests that the mind of a genius has a discernible shape and disposition.

Ultimately the goal is to explain how an eminent thinker arrives at his or her world-changing moment, or moments, of insight. Although such breakthroughs often seem to appear in a flash, the underlying mechanisms are likely to be much more orderly. According to one theory I helped to develop, a genius hunts widely—almost blindly—for a solution to a problem, exploring dead ends and backtracking repeatedly before arriving at the ideal answer. If this line of research bears out, we can start to investigate whether genius can be cultivated, unleashing a wealth of new ideas for the benefit of all.

The Meaning of Genius

The first hurdle in the study of genius is to settle on a working definition. The word itself harks back to ancient Roman mythology, according to which every male was born with a unique genius that served as a kind of guardian angel, and every female had a juno. Much later, after the Renaissance, the word became more exclusive in its application, with only a few people showing genius. Philosopher Immanuel Kant believed, for example, that a genius was someone who produced works that were both original and exemplary. The term did not acquire scientific meaning until the late 19th century, when psychologists came to define genius in two distinct ways.

The first approach was to identify genius with exceptional achievement, as Kant did. These accomplishments elicit admiration and emulation from other experts in that field and often the world at large. Unquestioned examples of such works include Newton's *Principia*, Shakespeare's *Hamlet*, Tolstoy's *War and Peace*, Michelangelo's Sistine Chapel frescoes and Beethoven's Fifth Symphony. Even though this definition can be extended to encompass extraordinary leadership, such as military brilliance, and prodigious performance, including some chess grandmasters, most scientific research concentrates on outstanding creativity within the sciences or the arts, which will also be the focus here.

The second definition of genius coincided with the emergence of intelligence tests in the first half of the 20th century. A genius was someone who scored sufficiently high on a standard IQ test—usually landing in the top 1 percent, with a score above 140, as proposed by psychologist Lewis Terman, the formulator of one of the original intelligence tests. These two definitions have little in common. Many persons with superlative IQs do not produce original and exemplary accomplishments. One example is Marilyn vos Savant, who was once certified by the *Guinness Book of World Records* as having the highest recorded IQ of any living person. Her weekly “Ask Marilyn” column for a Sunday newspaper supplement did not inspire a new genre of science, art or even journalism. And many exceptional achievers do not attain genius-level IQs. William Shockley, for example, received a Nobel Prize in Physics for coinventing the transistor yet had an IQ score well below 140. Exceptional achievement, then, seems the more useful measure.

Too often in popular writing, genius is conceived as a discrete category—this person is a genius, but that person is not. Yet just as people can vary in IQ, they can also differ in the magnitude of their creative achievements, with either a single notable contribution or a lifetime of prolific work. One such “one-hit wonder” is Gregor Mendel, who attained lasting fame for a single paper that reported his classic experiments in genetics. Had Mendel never taken an interest in breeding peas, his name would be unknown today. Charles Darwin's fame, in contrast, rests on far more than *On the Origin of Species*. Nobel laureate Max Born once said that Einstein “would be one of the greatest theoretical physicists of all time even if he had not written a single line on relativity.” Hence, Darwin and Einstein exhibited greater genius than did Mendel. Accordingly, much research is devoted to assessing relative degrees of genius—most often gauged by creative productivity.

Origins of Genius

Finding the sources of consummate creativity has occupied the minds of philosophers and scientists for centuries. In 1693 English poet John Dryden wrote, “Genius must be born, and never can be taught.” Two and a half centuries later French author Simone de Beauvoir countered, “One is not born a genius, one becomes a genius.” The first scientific investigation devoted exclusively to genius concerned this precise issue. In 1869 Francis Galton published *Hereditary Genius*, in which he argued that genius is innate, based on his observations that geniuses tend to emerge from lineages that included other brilliant individuals. In response to criticisms, Galton later introduced the well-known nature-nurture issue. He conducted a survey of famous English scientists to discover some of the environmental variables involved in nurturing brilliance, and he examined factors such as birth order and education.

By the second half of the 20th century psychologists had moved to an extreme nurture position, in which creative genius rested solely on the acquisition of domain expertise. This idea was frequently expressed as the “10-year rule.” Nobody can expect to reach the heights of creativity without mastering the necessary knowledge and skill because only experts can create—or so the thinking went. Indeed, Einstein learned lots of physics before he commenced his creative career.

This explanation cannot account for all the details, however. First, geniuses often spend less time acquiring domain expertise than their less creative colleagues. Studies have linked accelerated acquisition with long, prolific and high-impact careers. The 10-year rule is an average with tremendous variation around the mean. Further, major breakthroughs often occur in areas where the genius must create the necessary expertise from scratch. Telescopic astronomy did not exist until Galileo pointed his new instrument toward the night sky to discover what had never been seen before nor even expected. The moon had mountains, Jupiter had moons and the sun had spots!

Second, geniuses are more likely to exhibit unusually wide interests and hobbies and to display exceptional versatility, often contributing to more than one domain of expertise. This tendency was true not only in the era of Renaissance men but is also evident today. According to a 2008 study, Nobel laureates in science are more involved in the arts than less eminent scientists. Given that geniuses likely do not sleep any less than the rest of us, these extraneous activities would seem to distract from a dogged focus on a narrow field of interest. Einstein slept even more hours than the norm, but he still took time off to play Bach, Mozart and

Schubert on his violin. At times these avocational activities inspire major insights. Galileo was probably able to identify the lunar mountains because of his training in the visual arts, particularly in the use of chiaroscuro to depict light and shadow.

The expertise acquisition theory also undervalues the genetic components that underlie a large number of cognitive abilities and personality traits that correlate with genius. In a recent meta-analysis, I found that at least 20 percent of the variation in creativity could be attributed to nature. For example, creative achievement is strongly associated with the personality trait of openness to experience, a highly heritable characteristic. The broad interests in art and music of many geniuses are clear manifestations of this trait. Many other predictors of achievement also have high heritabilities, such as cognitive and behavioral flexibility, along with a tolerance of ambiguity and change.

Nurture may still account for the lion's share of genius, and mastering a domain remains central. At the same time, genetics contributes heavily to the rate at which someone acquires the necessary skills and knowledge. Those with more innate talent can improve faster, launch their careers earlier and be more productive. In addition, genetics may help explain the different trajectories of equally well-trained individuals. Einstein did not know as much physics as many of his contemporary theoretical physicists, but what he did know went a long way. He could honestly say, “Imagination is more important than knowledge.”

These influences are just a few of the ways genetics shapes the potential for genius. Let it suffice to note that I have probably understated the impact of genes on genius.

Madness and Magnificence

Researchers have long been tantalized by the question of whether the biological endowment of a genius also confers great setbacks. Greek philosopher Aristotle is reputed to have said, “Those who have become eminent in philosophy, politics, poetry and the arts have all had tendencies toward melancholia.” This idea received wide currency in the 19th and 20th centuries at the hands of psychiatrists and psychoanalysts. Among the great writers, Virginia Woolf, Anne Sexton and Sylvia Plath all committed suicide. Vincent van Gogh did as well, and earlier he had cut off part of his ear to give to a prostitute. Newton sometimes suffered from extreme paranoia, and Galileo, possibly an alcoholic, was often bedridden with depression. Nevertheless, many psychologists have argued that such cases are the exceptions, not the rule. Some positive psychologists today consider creative genius a human strength or virtue.

My 2005 review of the literature, which summarized studies with varied methodologies, indicates that the association between genius and mental illness has considerable strength. Very creative writers tend to obtain higher scores on the psychopathology-related parts of the Minnesota Multiphasic Personality Inventory, a widely accepted personality test. A study using another instrument, the Eysenck Personality Questionnaire, found that extremely creative artists—and high-impact psychologists, for that matter—tend to receive elevated scores on the test's psychoticism scale, meaning that they are, among other things, egocentric, cold, impulsive, aggressive and tough-minded. Last, highly eminent scientists score higher on sections of the Cattell 16 Personality Factor Questionnaire that signify they are withdrawn, solemn, internally preoccupied, precise and critical. All told, top performers are not a very normal bunch.

Psychiatric studies bolster these results. The rate and intensity of certain psychopathic symptoms, such as depression and alcoholism, are noticeably higher in very creative individuals than in the general population. Research also suggests that these divergent thinkers are more likely to come from family lines at higher risk for psychopathology. Even if an extraordinary innovator is “normal,” his or her family members may not be.

In line with these findings, in 2009 psychiatrist Szabolcs Kéri of Semmelweis University in Hungary found a genetic basis for both creativity and psychosis in a variant of the *Neuregulin 1* gene. In this study, Kéri recruited a group of highly creative individuals and found that the participants who had this specific gene variant, which is linked with an increased risk of developing a mental disorder, also scored higher on measures of creativity.

Out-and-out psychosis, however, can shut down creative genius. This tragic reality was dramatically illustrated in the 2001 film *A Beautiful Mind*, the biopic about Nobel laureate John Forbes Nash and his struggles with schizophrenia. The costs and burdens of psychological dysfunction are also immediately apparent in the art of the mentally ill, such as the works preserved in the Prinzhorn Collection in Heidelberg, done by psychiatric patients in the early 20th century. Few if any of these artworks show signs of genius. Quoting Dryden again, “wits are sure to madness near allied, and thin partitions do their bounds divide.”

Recent research conducted by psychologist Shelley Carson of Harvard University and her colleagues has sought to identify these thin partitions. Creative achievement is positively associated both with cognitive disinhibition—openness to supposedly extraneous ideas, images or stimuli—and higher intelligence and greater working memory. These mental capacities can potentially ameliorate the negative effects of disinhibition and even channel them to more useful ends. This synergy may well constitute the cognitive basis for serendipity. Not everybody would be able to work out the profound implications of such humdrum events as water overflowing a bathtub or an apple falling from a tree. But Archimedes and Newton did. [For more on creativity and eccentricity, see “The Unleashed Mind,” by Shelley Carson; Scientific American Mind, May/June 2011.]

Thinking Outside the Box

Archimedes and Newton both worked in scientific fields, raising the possibility that their brands of creativity may have been similar. A more revealing question might be to investigate how their route to original thought compares with that of a superlative writer or musician. A physicist's way of thinking has little, if anything, in common with that of a painter. For example, learning how to solve a differential equation has as much utility for a painter as learning linear perspective has for a physicist—zero in most cases. Yet the themes uniting geniuses, as discussed earlier, suggest that a common creative principle may exist. Domain expertise, such as the knowledge of advanced problem-solving strategies, supports thinking that is routine, even algorithmic—it does not inherently lead to the generation of novel, useful and surprising ideas. Something else must permit a person to go beyond tradition and training to reach the summit of genius.

According to a theory proposed in 1960 by psychologist Donald Campbell, creative thought emerges through a process or procedure he termed blind variation and selective retention (BVSR). In short, a creator must try out ideas that might fail before hitting on a breakthrough. Campbell did not precisely define what counts as a

blind variation, nor did he discuss in any detail the psychological underpinnings of this process. As a result, his ideas were left open to criticism.

Using a mixture of historical analyses, laboratory experiments, computer simulations, mathematical models and case studies, I have devoted the past 25 years to developing BVSR into a comprehensive theory of creative genius in all domains. The blindness of BVSR merely means that ideas are produced without foresight into their eventual utility. The creator must engage in trial-and-error or generate-and-test procedures to determine the worth of an idea. Two common phenomena characterize BVSR thinking: superfluity and backtracking. Superfluity means that the creator generates a variety of ideas, one or more of which turn out to be useless. Backtracking signifies that the creator must often return to an earlier approach after blindly going off in the wrong direction. Superfluity and backtracking are often found together in the same creative episode. Exploring the wrong track obliges a return to options that had been originally cast aside.

The reflections of Hermann von Helmholtz, a prolific physicist with numerous creative breakthroughs to his name, capture this process of discovery:

I had to compare myself with an Alpine climber, who, not knowing the way, ascends slowly and with toil, and is often compelled to retrace his steps because his progress is stopped; sometimes by reasoning, and sometimes by accident, he hits upon traces of a fresh path, which again leads him a little further; and finally, when he has reached the goal, he finds to his annoyance a royal road on which he might have ridden up if he had been clever enough to find the right starting point at the outset.

This account of venturing blindly into uncharted territory and retracing steps resonates with evidence from other eminent creators. As Einstein once said, “If we knew what we were doing, we wouldn't call it research.”

To see superfluity and backtracking in practice, consider the sketches that Pablo Picasso produced in preparation for his 1937 *Guernica* painting. Among them are clearly “superfluous” sketches, which have a human head on a bull's body (for example, sketches 19 and 22 on the opposite page). Picasso soon discovered that this was a dead end and backtracked to an earlier bull's head drawing (15), before continuing to the final two sketches (26 and 27). Notice that the artist went too far in one direction in the last sketch, from which he backtracked yet again. Even more telling, after that last sketch Picasso largely reversed himself to a much earlier formulation (11), which shares the most unique features with the final version: the widely separated eyes, the thin-lipped open mouth with tongue, the menacing rather than inert visage and the Cubist rather than neoclassic style. These sketches are typical of blind variations both in the arts and in the sciences.

Only further research can expand the theory into a comprehensive, predictive model whose claims can be thoroughly tested. Even so, BVSR can help us make sense of certain quirks of the creative genius, including their personality traits and developmental experiences. Although they devote considerable time to achieving expertise, they also pursue other hobbies. Their openness to new ideas and their breadth of interests infuse them with seemingly irrelevant stimulation that can enrich blind variations.

As 19th-century German philosopher Arthur Schopenhauer said, “Talent hits a target no one else can hit; genius hits a target no one else can see.” Exceptional thinkers, it turns out, stand on common ground when they launch their arrows into the unknown.