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Unleashing Creativity

Moments of brilliance arise from complex cognitive processes. Piece by piece, researchers are uncovering the secrets of creative thinking

By Ulrich Kraft

Nancy Chang, a high school art teacher in San Francisco, had been painting since she was a child. She varied her technique from Western-style watercolors to classical Chinese brushstrokes, but she always strove for realism: painting landscapes and people in social settings as literally as she could. Then, in 1986, at age 43, she began to have problems performing her job. Grading, preparing for class, putting together lesson plans--everything that she had previously done with ease--became increasingly difficult over the next few years. By 1995 she could no longer remember the names of her students and was forced to take early retirement.

Understandably frightened, Chang had started seeing neurologist Bruce L. Miller, clinical director of the Memory and Aging Center at the University of California at San Francisco. He diagnosed her with frontotemporal dementia. This relatively rare form of dementia selectively damages the temporal and frontal lobes, primarily in the brain's left hemisphere. These regions control speech and social behavior and are intimately involved in memory. Patients often become introverted, exhibit compulsive behaviors and lose inhibitions that would otherwise prevent them from acting inappropriately toward others in social settings.

Afflicted people lose regard for social norms, yet this lack of inhibition allows artistry to bloom.

Miller observed all these changes in Chang, but he also found that her creative powers were growing remarkably. "The more she lost her social and language abilities, the wilder and freer her art became," he notes. The same lack of inhibition that caused embarrassing moments in public allowed her to break the shackles of her realism art training and become increasingly impressionistic and abstract. Her paintings were much more emotionally charged.

Miller was astonished. The last place he expected talent to bloom was in the brain of a person whose mental functions were deteriorating because of crumbling neurons. But it turned out that Chang was not an isolated case. Miller later identified other men and women whose latent creativity burst forth as frontotemporal dementia set in--even in patients who had little prior interest in artistic pursuits. One man, a stockbroker who had never before been touched by the muse, traded his conservative suits for the most radical styles he could find. He developed a passion for painting and went on to win several art prizes. Another person began to compose music even though he had no musical training. A third invented a sophisticated chemical detector at a stage when he could recall only one in 15 words on a memory test.

The ability to create is one of the outstanding traits of human beings. From harnessing fire to splitting the atom, an inexhaustible stream of innovative flashes has largely driven our social development. Significant insight into the neuronal mechanisms underlying the creative thought process is coming from work with patients who, like Chang, have suddenly acquired unusual skills as a result of brain damage. Using technical advances such as functional magnetic resonance imaging and electroencephalography, neuroscientists are trying to determine just where those sparks originate.

Schools place overwhelming emphasis on solving problems correctly, not creatively.

Scientific understanding of creativity is far from complete, but one lesson already seems plain: originality is not a gift doled out sparingly by the gods. We can call it up from within us through training and encouragement. Not every man, woman or child is a potential genius, but we can get the most out of our abilities by performing certain kinds of exercises and by optimizing our attitudes and environment--the same factors that help us maximize other cognitive powers. Some of the steps are deceptively simple, such as reminding ourselves to stay curious about the world around us and to have the courage to tear down mental preconceptions. Steven M. Smith, a professor of psychology at the Institute for Applied Creativity at Texas A&M University, says many people believe that only a handful of geniuses are capable of making creative contributions to humanity: "It just isn't true. Creative thinking is the norm in human beings and can be observed in almost all mental activities."

The ease with which we routinely string together appropriate words during a conversation should leave no doubt that our brains are fundamentally creative. What scientists are trying to discover is why the engine of inspiration seems to be always in high gear in some people while others struggle.

It's Not Intellect

Intelligence is not a crucial ingredient. U.S. military leaders recognized this seeming contradiction more than 50 years ago. During World War II, the U.S. Air Force sought to identify fighter pilots who would be able to get out of jams in unorthodox ways. Officials wanted pilots who would not simply bail out in an emergency but who would be more likely to save themselves and their aircraft. Initially, military scouts used conventional intelligence tests to identify such candidates. But they soon realized a high IQ was useless in finding inventive superpilots, and they resorted to more anecdotal measures.

Around the same time, psychologist Joy Paul Guilford of the University of Southern California noted that intelligence did not mirror the totality of a person's cognitive capacity. In the late 1940s Guilford developed a model of human intellect that formed the basis for modern research into creativity. A crucial variable is the difference between "convergent" and "divergent" thinking.

All of us can call up originality from within our minds through training and encouragement.

Convergent thinking aims for a single, correct solution to a problem. When presented with a situation, we use logic to find an orthodox solution and to determine if it is unambiguously right or wrong. IQ tests primarily involve convergent thinking. But creative people can free themselves from conventional thought patterns and follow new pathways to unusual or distantly associated answers. This ability is known as divergent thinking, which generates many possible solutions. In solving a problem, an individual proceeds from different starting points and changes direction as required, which Guilford explained leads to multiple solutions, all of which could be correct and appropriate.

Guilford tried to find a measurable "creativity quotient" analogous to IQ, but his efforts and those of other researchers since his time have all failed. A few techniques, such as the Torrance Test of Creative Thinking, can give a sense of which people in a test group may be more creative. But deciding which of their many responses can be characterized as especially creative is simply too dependent on the personal judgment of the tester.

Rather than using a standardized test, today's creativity experts look for certain characteristics that people who excel at divergent thinking seem to exhibit. The following are prime examples:

Ideational fluency. The number of ideas, sentences and associations a person can think of when presented with a word.

Variety and flexibility. The diversity of different solutions a person can find when asked to explore the possible uses of, say, a newspaper or a paper clip.

Originality. The ability to develop potential solutions other people do not reach.

Elaboration. The skill to formulate an idea, expand on it, then work it into a concrete solution.

Problem sensitivity. The ability to recognize the central challenge within a task, as well as the difficulties associated with it.

Redefinition. The capacity to view a known problem in a completely different light.

Left or Right?

Guilford's distinction between convergent and divergent thinking prompted neuroscientists to examine whether the two processes took place in different brain regions. Their experiments, particularly those conducted in the 1960s by psychobiologist Roger W. Sperry of the California Institute of Technology, revolutionized neurology and psychology. Sperry worked with so-called split-brain patients who suffered from epilepsy that did not respond to conventional medical treatment. The only way to end their horrible seizures was to surgically sever their corpus callosum, the fibrous structure that links the brain's left and right hemispheres.

Sperry and his colleague Michael Gazzaniga, now at Dartmouth College, put patients through a series of sophisticated experiments, which led to the breakthrough discovery that the left and right hemispheres do not process the same

information. Sperry won the 1981 Nobel Prize in Physiology or Medicine for the work. Among other duties, the left hemisphere is responsible for most aspects of communication. It processes hearing, written material and body language. The right hemisphere processes images, melodies, modulation, complex patterns such as faces, as well as the body's spatial orientation.

The functional differences between the hemispheres are the subject of intense research today. Studies of stroke patients confirm the basic division of labor. Damage to the right hemisphere, for example, leaves speech largely intact but harms body awareness and spatial orientation. But researchers have noted another interesting correlation: patients with right hemisphere strokes lose whatever creative talents they had for painting, poetry, music, even for playing games such as chess.

The accumulation of experimental evidence now proves that the left hemisphere is responsible for convergent thinking and the right hemisphere for divergent thinking. The left side examines details and processes them logically and analytically but lacks a sense of overriding, abstract connections. The right side is more imaginative and intuitive and tends to work holistically, integrating pieces of an informational puzzle into a whole.

Consider a poem. When an individual reads it, his left hemisphere analyzes the sequence of letters and integrates them into words and sentences, following the logical laws governing written language. It checks for grammatical and morphological meaning and grasps the factual content. But the right hemisphere interprets a poem as more than a string of words. It integrates the information with its own prior ideas and imagination, allows images to well up, and recognizes overarching metaphorical meaning.

Creativity Unleashed

The right hemisphere's divergent thinking underlies our ability to be creative. Curiosity, love of experimentation, playfulness, risk taking, mental flexibility, metaphorical thinking, aesthetics--all these qualities play a central role. But why does creativity remain so elusive? Everyone has a right hemisphere, so we all should be fountains of unorthodox ideas.

Consider that most children abound in innovative energy: a table and an old blanket transform into a medieval fortress, while the vacuum cleaner becomes the knight's horse and a yardstick a sword. Research suggests that we start our young lives as creativity engines but that our talent is gradually repressed. Schools place overwhelming emphasis on teaching children to solve problems correctly, not creatively. This skewed system dominates our first 20 years of life: tests, grades, college admission, degrees and job placements demand and reward targeted logical thinking, factual competence, and language and math skills--all purviews of the left brain. The propensity for convergent thinking becomes increasingly internalized, at the cost of creative potential. To a degree, the brain is a creature of habit; using well-established neural pathways is more economical than elaborating new or unusual ones. Additionally, failure to train creative faculties allows those neural connections to wither. Over time it becomes harder for us to overcome thought barriers. Creativity trainers like to tell clients: "If you always think the way you always thought, you'll always get what you always got--the same old ideas."

Bruce Miller's examination of Jancy Chang and other patients like her lends credence to the notion that the logical left hemisphere may block the creative right side. With the help of imaging techniques, Miller has determined that people with frontotemporal dementia lose neurons primarily in the left hemisphere. Patients have trouble speaking and show no regard for social norms. And yet this very lack of inhibition allows dormant artistic talents to bloom. Miller draws parallels to creative geniuses such as Vincent van Gogh and Francisco Goya, who ignored social expectations and developed unorthodox styles that opposed contemporary conventions. Great artists often exhibit an ability to transcend social and cognitive walls.

Nevertheless, it is wrong to assume that the left hemisphere is all that stands in the way of genius. Not every unconventional idea is necessarily a good one; many completely miss a problem at hand or are simply outlandish. The most important creative work is useful, relevant or effective. And it is the left hemisphere that conducts this self-evaluation as creative thoughts bubble up from the right. As Ned Herrmann, artist, actor, management trainer and author of The Creative Brain (Ned Herrmann Group, 1995), notes, the left brain keeps the right brain in check. Creativity involves the entire brain.

Voyage of Discovery

Convergent thinking is also required for a creative breakthrough. Inspirational thunderbolts do not appear out of the blue. They are grounded in solid knowledge. Creative people are generally very knowledgeable about a given discipline. Coming up with a grand idea without ever having been closely involved with an area of study is not impossible, but it is very improbable. Albert Einstein worked for years on rigorous physics problems, mathematics and even philosophy before he hit on the central equation of relativity theory: $E = mc^2$. As legendary innovator Thomas A. Edison, author of 1,093 patents, noted drily, "Genius is 1 percent inspiration and 99 percent perspiration."

Various psychologists have floated different models of the creative process, but most involve an early "preparation"

phase, which is what Edison was talking about. Preparation is difficult and time-consuming. Once a challenge is identified, a person who wants to solve it has to examine it from all sides, including new perspectives. The process should resemble something like an intellectual voyage of discovery that can go in any direction. Fresh solutions result from disassembling and reassembling the building blocks in an infinite number of ways. That means the problem solver must thoroughly understand the blocks.

Smith of Texas A&M emphasizes how important it is to be able to combine ideas. He says people who are especially inventive have a gift for connecting elements that at first glance may seem to have nothing in common. To do that, one must have a good grasp of the concepts. The more one knows, the easier it will be to develop innovative solutions.

In this context, psychologist Shelley H. Carson of Harvard University reached an interesting insight in 2003. She analyzed studies of students and found that those who were "eminent creative achievers"--for example, one had published a novel, another a musical composition--demonstrated lower "latent inhibition" on standard psychological tests than average classmates. Latent inhibition is a sort of filter that allows the brain to screen out information that has been shown by experience to be less important from the welter of data that streams into our heads each second through our sensory system. The information is cast aside even before it reaches consciousness. Think about your act of reading this article right now; you have most likely become unaware that you are sitting in a chair or that there are objects across the room in your peripheral vision.

Screened data take up no brain capacity, lessening the burden on your neurons. But they are also unavailable to your thought process. Yet because creativity depends primarily on the ability to integrate pieces of disparate data in novel ways, a lower level of latent inhibition is helpful. It is good to filter out some information, but not too much. Then again, lower latent inhibition scores have been associated with psychosis.

Latent inhibition has a corollary: too much specialized knowledge can stand in the way of creative thinking. Experts in a field will often internalize "accepted" thought processes, so that they become automatic. Intellectual flexibility is lost. For example, a mathematician will very likely tackle a difficult problem in an analytical way common to her professional training. But if the problem resists solution by this method, she may well find herself at a mental dead end. She has to let go of the unsuitable approach.

The Bathtub Principle

Letting go to gain inspiration may be difficult. One aid is to simply get away from the problem for a while. Creativity does not prosper under pressure. That is why so many strokes of genius have occurred outside the laboratory, in situations that have nothing to do with work. Legend has it that when Greek mathematician and mechanical wizard Archimedes was stepping into a bathtub when the principle of fluid displacement came to him--the original "eureka!" moment. Organic chemist Friedrich August Kekulé had a dream about snakes biting their own tails; his eureka moment occurred the next morning, when he depicted the chemical structure of benzene as ring-shaped.

Creative revelations come to most people when their minds are involved in an unrelated activity. That is because the brain continues to work on a problem once it has been supplied with the necessary raw materials. Some psychologists call this mental fermentation or incubation. They surmise that associative connections between ideas and imagination that already exist in the mind become weaker and are transformed by new information. A little relaxation and distance changes the mind's perspective on the problem--without us being aware of it. This change of perspective allows for alternative insights and creates the preconditions for a fresh, and perhaps more creative, approach. The respite seems to allow the brain to clear away thought barriers by itself. At some point, newly combined associations break into consciousness, and we experience sudden, intuitive enlightenment.

The little insights and breakthroughs we all experience should encourage us to believe that bigger eureka moments are possible for anyone. Our brains bestow moments of illumination almost as a matter of course, as long as there has been adequate preparation and incubation. The catch is that because the neural processes that take place during creativity remain hidden from consciousness, we cannot actively influence or accelerate them. It therefore behooves even the most creative among us to practice one discipline above all--patience.