STEVE SILBERMAN DEC 1, 2003 12:00 PM

The Key to Genius

AUTISTIC SAVANTS ARE born with miswired neurons – and extraordinary gifts. The breakthrough science behind our new understanding of the brain.

Matt Savage launched his jazz career by attempting to improve a Schubert sonata. His piano teacher told him that the G-sharp he just played was supposed to be a G-natural. "It sounds better my way," he protested. She replied that only when he wrote his own music could he take liberties with a score. Keen

| Michael Elins **Michael Elins Matt Savage is a jazz phenomenon. He's also a perseverative hyperlexic with pervasive developmental disorder.**

In May, he will celebrate his 12th birthday.

Matt is a musical savant. The term savant dates from the late 19th century, when a small number of people in European asylums classified as feebleminded "idiots" were discovered to have extraordinary, even uncanny skills. One had memorized *The Decline and Fall of the Roman Empire* after reading it a single time. Others were able to multiply long columns of numbers instantly and factor cube roots in seconds, though they could barely speak.

When Matt was 3, he was diagnosed with a form of autism called pervasive developmental disorder. Autism and savant syndrome overlap, but they are not the same thing. Nine out of ten autistic people have no savant abilities, and many savants suffer from some form of neurological impairment other than autism. Savant syndrome itself is rare. The rarest of the rare is the prodigious savant, like *Rain Man's* Raymond Babbitt, who could memorize phone books, count 246 toothpicks at a glance, and trump the house in Vegas. Darold Treffert, the leading researcher in the study of savant syndrome, estimates that Matt is one of fewer than 50 prodigious savants alive today.

But Matt is even rarer than that. While the IQs of most savants are below 70, he is highly intelligent. And while the musical prowess of savants is often confined to playing thousands of songs from memory in a stiff and mechanical way, Matt is a prolific composer and skilled improviser. With the precocious abilities of a savant and the melodic imagination of a seasoned musician, he has dual citizenship in two countries

His Wife for a Hat. Now researchers are probing the savant mind from the inside, using tools like gene mapping and PET scans. As these two paths of investigation converge, many of our long-held notions about the limits of human potential are being overturned.

By studying the minds of people like Matt, neuroscientists are discovering that savants are more like the rest of us than the medical world once believed. We're learning that the extraordinary skills of savants tap into areas of the mind that function like supercomputers, compiling massive amounts of data from the senses to create a working model of the world. The traditional conception of the brain – two hemispheres that are hardwired from birth – is yielding to an understanding of the ways the regions of the cortex learn to function together as a network.

"We used to have this idea that we were born with a magnificent piece of hardware in our heads and a blank disk called memory," says Treffert. "Now we have to acknowledge that the disk comes with software, that we were wrong in many of our assumptions about intelligence, and that the brain is much more capable of healing itself than we thought. By finding out how savants work, we learn how we work."

I meet Matt and his mother, Diane, both fresh from a TV appearance, for lunch at a hotel in midtown Manhattan. Four and a half feet tall, with huge brown eyes that seem to devour whatever he focuses on, Matt is as restless physically as he is mentally. He doesn't so much sit in a chair as climb around it.

The unusual timbre of his mind is immediately apparent. Scanning the menu, he exclaims, "Soy sauce on salmon, that's triple *s*!" After the salmon arrives, he asks me my birthday – December 23, 1957.

artistic and musical proficiency, mechanical aptitude, and feats of memorization. These tasks draw primarily on the strengths of the brain's right hemisphere, indicating that, in many savants, a healthy right hemisphere is overcompensating for damage to the left. Many savants are left-handed, and most have deficits in language – additional clues that something is amiss in the left hemisphere.

In autistic savants, like Matt, the problems are more pervasive. Autism rewires the brain's entire network, from the limbic system to the executive functions in the frontal lobes that enable us to absorb new experiences, prioritize tasks, set goals, and imagine the future. When these are damaged, we're at the mercy of a flood of incoming sensory impressions and conflicting impulses.

I can see this in Matt as his eyes dart around the restaurant. He's intensely awake to the world but perpetually distractible. Being with him is exhilarating and exhausting. While I scribble in my notebook, he slaps his hand on the table. "This is not lunch, this is questions," he groans. "Let's do something interesting like proportions at work!" Then a torrent bursts out of him: *Did you know that if you had the metabolism of a shrew you would have to eat 600 hamburgers a day? Or that if you grew as fast as a snake you would be taller than mountaintops and heavier than two and a half million elephants in a month? And if you could jump like a flea, you could leap over Lady Liberty's torch!*

There's a mechanical quality to Matt's relentless enumerations, as if his brain copes with information overload by siphoning the river of his experience into streams of quantities and ratios.

For Matt, the constraints of harmony and rhythm must be comforting, while the freedom of improvisation offers him a kind of measured release. Savants are drawn in particular to the piano, which neatly

the band stopped playing, she felt the baby inside her "kicking for more," she says. "I felt happy that he was so responsive to what was happening outside of his little world."

But soon after Matt was born, it became obvious that his acute sense of hearing was overwhelming him. He would stop nursing if Diane spoke even a word while he was at her breast. The din of windshield wipers, blenders, and vacuum cleaners was excruciating to him. He seemed unusually bright – he started reading street signs and counting his Cheerios out loud before his first birthday. But his speech was decidedly odd. If Matt was thirsty, he would hold up a cup and say, "Do you want juice?"

When Diane and her husband, Larry, tried to socialize with other parents, Matt would run out of the house. His preschool expelled him after two days for refusing to stay in his chair. Diane loved to play piano, but once her son's hypersensitivities became the prevailing weather in the household, the upright in the family room sat silent. If she settled down to play, Matt would yell, "No!" and snatch her hands off the keys.

Clearly, something was wrong. Diane brought her son to Children's Hospital in Boston for a thorough neurological workup. The doctor had to lie on the floor beside Matt to get him to focus on their conversation.

He looked at Diane gravely and said, "Your son has pervasive developmental disorder with hyperlexia. He's perseverative and echolalic and speaks in a Gestalt manner." Diane diligently took notes. Finally she asked him, "What does this all mean?"

sounds. At the same time, the positive aspects of Matt's quirky brain began to emerge. Unlike many autistic kids, he can read other people's feelings. And his habit of counting Cheerios had ripened into a passion for numbers.

When Matt was 6, he confided to his mother, "My mind is made of math problems." Diane started buying him math workbooks for kids twice his age. He zipped through them so quickly, she learned to hide a few in a drawer so he'd have something to work on the following day.

Then one night, Diane and Larry heard a melody coming from downstairs. It was their son, playing "London Bridge" on a toy keyboard. Diane brought Matt into the family room and introduced him to the middle C on the piano. Within a day, he was devouring music books as hungrily as he had math books.

Matt took classical lessons for a year, then Diane enrolled him in the jazz program at the New England Conservatory of Music. Upon meeting his first jazz instructor there, a bearish Israeli whose last name is Katsenelenbogen, Matt cried out, "Six syllables!"

Teaching Matt was a challenge – at first, he would strike a single note on the piano and run to the back of the room to stand on his head. But Eyran Katsenelenbogen was an empathetic teacher. "I have always performed and recorded solo," he says. "There's something slightly autistic about that."

Matt progressed quickly. Other students would learn two or three pieces in a lesson, while Matt would tear through a dozen. Katsenelenbogen came to see a connection between Matt's hyperspeed number-crunching and his jazz mind: "Matt has an amazing ability to calculate relationships between chords and

be factored into one another – but I also felt he was using those words in their ordinary sense. Matt is intimate with numbers. They come to him in dreams and inspire him to write songs. One of his tunes on the album *Groovin' on Mount Everest* is called "Forty-Seven" – a number he feels is "lonely" because when he asks people to think up a random number, no one ever chooses it.

The philosopher-mathematician Gottfried Leibniz called music unconscious counting. The music of Matt's consciousness is mathematics.

Geneticists are starting to pinpoint the DNA anomalies found in kids like Matt who are savants from birth. Still, a single savant gene will probably never be found. More than a dozen genes may contribute to autism. Several other forms of mental impairment also produce islands of startling ability – known as splinter skills – as if fragments of savant code are scattered throughout the genetic database.

Last year, researchers at Vanderbilt University discovered a cluster of abnormalities on chromosome 15 in the families of autistic savants. Another set of irregularities on the same chromosome produces learning-disabled kids who can solve jigsaw puzzles twice as fast as other children and have an insatiable desire to overeat – Prader-Willi syndrome. A third chromosomal disorder, called Williams syndrome, results in mental retardation, poor coordination, and a different set of splinter skills. Williams kids, who have distinctively elfin facial features, are naturally outgoing, love to schmooze, and have a propensity for florid verbal constructions (hyperlexia), similar to Matt's discourse on proportions.

Like savants, people with Williams syndrome have an unusual relationship with the audible world. Some are terrified as children by the hum of household appliances, but others become connoisseurs of the rich

In tests conducted at a music camp in Massachusetts, psychologists found that the errors made by Williams kids were more *musical* than those made by a control group. On a clapping test, those in the control group sometimes just dropped the beat, but the Williams kids made mistakes that elaborated on the rhythms. They were jamming.

In the same way that Matt's mind is made of math problems, the minds of Williams syndrome kids are made of sound. As one girl told a researcher, "Music is my favorite way of thinking."

In the 1980s, the search for a single cause underlying the various forms of savant syndrome led neurologists Norman Geschwind and Albert Galaburda to propose a bold theory that would account for autism, dyslexia, stuttering, and a number of other disorders that seem to have a basis in left-hemisphere dysfunction.

Male savants outnumber females 5 to 1. The problem, hypothesized Geschwind and Galaburda, is testosterone.

The nerve cells in a fetal brain proliferate at an astonishing rate, with 250,000 neurons born every minute. These cells are engaged in a fierce Darwinian contest. The goal: interconnectedness.

In a fetus that is developing normally, those neurons that do not form synaptic links with the other cells are killed off before birth. After eight weeks of gestation, the testes in a male fetus start pumping out nearly as much hormone as they will at puberty, and Geschwind and Galaburda theorized that in some brains, this flood of testosterone interferes with the assembly of the neural network, resulting in a tangle

children are born with brains that are smaller than normal. In the first year, however, their brains grow dramatically until they're larger than normal, reaching maximum size at age 4 or 5 – eight years earlier than the brains of most people.

The brains of typical children grow in response to lessons learned from the environment – that was one of the significant upgrades in the evolution of Homo sapiens. As new stimuli are absorbed, the neurons in the cortex adapt gradually, and synaptic connections are forged or eliminated. Our brains are cast in the image of our experience.

The overgrowth of the brain tissue of autistic kids, however, is random and automatic, a reaction to an unknown stimulus – perhaps testosterone or some toxic agent in the environment. The result, says Courchesne, is an onslaught of neural noise that makes the infant lose the ability to make sense of its world.

The director of the Autism Research Centre at Cambridge University, Simon Baron-Cohen, makes the case in his new book *The Essential Difference* that autism represents an extreme manifestation of the "male brain." In his view, male brains are hardwired for "extracting the underlying rules that govern a system." (He carefully adds, "Your sex does not determine your brain type.") While the jury is still out on testosterone, a set of clinical studies in the UK confirm that both male and female savants are better at extracting the rules that govern systems than normal people.

Psychologists Beate Hermelin, Neil O'Connor, and John Sloboda hosted a neuromusical battle of the bands between a 19-year-old musical savant and a professional pianist. The researchers played Edvard

the piece equally well, without hearing it again, the following day.) The professional pianist, however, remembered less than half the piece and hit 10 times as many wrong notes. The professional pianist fared better on "Mikrokosmos," making not nearly as many mistakes, though he still recalled far fewer notes than the savant.

By analyzing all of the performances, the researchers concluded that the savant memorized Grieg's piece more easily than Bart�k's because "Melody" obeys the rules of classical diatonic form – rules that he had already extracted in the normal course of listening to music. But Bart�k's music intentionally breaks those rules. The professional pianist simply played back whatever notes he heard. For the savant, trying to reconstruct "Mikrokosmos" was like trying to recall syntactic structures in a language he didn't speak.

Hermelin and her colleagues found that savants also use rule-based strategies for calendar calculating. For a long time, the assumption was that they memorized tens of thousands of day-date pairings during months of obsessive practice. But as in music, the researchers discovered that when figuring dates in the distant past or future, savants supplement their prodigious memories with algorithms they derive from the cycles of the calendar.

In *The Man Who Mistook His Wife for a Hat*, Oliver Sacks wrote memorably about the calculating twins, George and Charles, who amused themselves for hours trading six-digit prime numbers with what Sacks described as "holy intensity." The twins were incapable of performing even simple multiplication. They told Sacks that they saw prime numbers just appear in their minds.

In most savants, these processes are as invisible to them as our own cognitive strategies are to us. Matt

To understand how even profoundly retarded savants can do such complex calculations subconsciously, Darold Treffert says, requires an examination of one of the oldest, least-evolved regions of the brain: the primitive storehouse of memory.

Trim and soft-spoken at 70, Treffert met his first savants in 1962 at a Wisconsin state hospital where he was assigned to found a new children's unit. One young patient named David had memorized the timetables for the entire Milwaukee bus system; given a route number, he could announce the scheduled location of a bus at any time of day. Another boy, Tony, would rattle off an exhaustive list of historical events that occurred on that day. He sounded "like the radio announcer on the morning show I listened to on the way to work – except that the announcer read it from an almanac. Tony was an almanac," Treffert wrote in *Extraordinary People: Understanding Savant Syndrome*.

There is no single unified memory function in the brain. Just as there are many types of remembering – retaining a phone number long enough to dial it, recollecting Proustian panoramas after a bite of madeleine – there is a diverse set of subsystems for imprinting experience in the mind.

The memories of savants run deep but narrow. They can recite, forward or backward, the contents of a book they've read and tell you the number of steps they took to the store. Their memories are high-fidelity – concrete, precise, and comprehensive – but there is little emotion in them. Musical savants are frequently described as human tape recorders.

This oddly adhesive memory is what binds together every domain of savant skill. In the brains of savants, Treffert believes, associative memory systems located in the higher regions of the cortex fail, and older

recorder and a book of rules. But to play Bach with fire and originality requires Proustian memory, with its nuanced webs of association and metaphor. This higher-order memory, like a living text, is constantly under revision. It's not just that savants remember everything, says Treffert, it's that they are unable to forget anything, like the protagonist in Jorge Luis Borges' short story, "Funes the Memorious."

Treffert is convinced that some savants don't have to learn the algorithms involved in tasks like calendar calculating. The software comes preinstalled. "You have to go beyond talking about traits," he says, "and start talking about the genetic transmission of knowledge."

The drawing abilities of most savant artists, for example, burst forth with no preparation, no training, and no practice – as if their skills were already there, fully fledged, needing only access to a pencil or a brush.

Children who seem to come into the world with profound artistic gifts have been objects of fascination for centuries, but recent discoveries suggest we may all carry a savant inside us waiting to be born.

One of the first researchers to propose this radical notion was UC San Francisco neurologist Bruce Miller, who noticed that certain people diagnosed with frontotemporal dementia, or FTD, suddenly develop aptitudes for music and art when their language faculties are ravaged by the disease.

One patient of Miller's, a 78-year-old linguist, began composing classical music soon after the onset of dementia, though he had little musical training; he felt that his mind was being "taken over" by notes and intervals. Another patient, an established landscape artist, turned toward abstraction and painted even more expressively as her verbal skills declined. Brain scans of FTD patients confirm patterns of damage

pursuits just as savants do with their timetables, maps, and daily routines. The landscape artist, a 57-year-old woman, stopped working alone in her studio and began sketching people in caf�s and painting nudes.

Miller formulated a provocative hypothesis to explain the fact that as some FTD patients get worse, they also get better. He posited that the dementia does not create artistic powers in these patients, it *uncovers* them. The disorder switches off inhibitory signals from the left temporal lobes, enabling suppressed talents in the right hemisphere to flourish.

This ability of the brain to heal itself and compensate for loss of function is called neuroplasticity. But the brain's ability to redraw its own cortical maps on the fly is not limited to routing around damage.

In Germany, a young man named R�diger Gamm, who is not autistic and did poorly at math in school, has trained himself to divide prime numbers to the 60th decimal point, calculate fifth roots, and raise numbers to the ninth power in his head – skills previously thought to be the lofty province of math geniuses and savants like the calculating twins.

People typically use short-term memory to solve math problems, but PET scans show that Gamm has recruited areas of his long-term episodic memory – the neurological archive of his life story – to perform his lightning calculations. Brian Butterworth of the Institute for Cognitive Neuroscience in London compares what Gamm is doing to the way "computers extend the capacity of RAM by using swap space on the hard drive to create a larger 'virtual memory.'"

with the left. But among professional musicians, both are tracked with the left, which handles behaviors that have become routine. MRI scans show that skilled violinists have enlarged areas of tissue in the left planum temporale, an auditory crossroads that serves both music and language.

The left planum temporale is also home to one of the most enviable savant skills, called absolute pitch. Mozart had it when he was 7 – a family friend wrote that "on hearing a bell toll or a clock, or even a pocket watch, strike, he was able at the same moment to name the note." While relative pitch (the ability to judge that one note is A after being given another note, like C) is common, absolute pitch is considered rare even among professional musicians. But many people with Williams syndrome have absolute pitch, as do nearly all musical savants.

Diana Deutsch, an expert in music cognition, discovered that, as children, we all may have had Mozart's ear for identifying notes but then lost it – unless we were lucky enough to grow up speaking tonal languages such as Mandarin, Cantonese, or Vietnamese. It turns out that speakers of these languages use absolute pitch every day, but in conversation, rather than in the concert hall.

Deutsch digitally compared recordings of native speakers of Chinese and Vietnamese saying the same phrases on different days. In Mandarin, *ma* can mean *mother, horse,* or *hemp*, with the rising or falling tones determining the meaning. The tones employed on different days were remarkably consistent, varying as little as a quarter of a semitone, the smallest interval in Western music.

"It looks as though there's a critical period when every infant has the opportunity to learn absolute pitch, *if* they grow up in a culture where pitch is associated with meaning," Deutsch explains. By starting music

suffer the kinds of brain trauma seen in Miller's dementia patients. In a laboratory in Australia, one self-styled revolutionary has taken up the cause of liberating our inner savant from the benevolent tyranny of the left hemisphere.

Trained as a physicist, Allan Snyder helped usher in the modern fiber-optics era with his breakthroughs in optical waveguide transmission in the 1960s. At the Centre for the Mind in Sydney, Snyder has built on the work of Treffert, Sacks, and others to suggest that autistic savants have "privileged access" to the mind's raw data before it's parsed and filtered by the brain's executive functions.

Musical savants, in his view, have absolute pitch because they tap directly into the discrete frequency receptors in the cortex without any left-hemisphere meddling. Savant artists draw with exceptional accuracy, he says, because "they see the world as it really is."

"Our knowledge and expertise blind us," Snyder told me last spring. "If we could switch off our conceptual mind, we could have a momentary literal viewing of the world."

Where Snyder and his mentors part ways is on how to go about switching off the conceptual mind. His method is to create a "virtual lesion" in the left temporal lobes by bombarding them with magnetic pulses, using transcranial magnetic stimulation. Volunteers given TMS, Snyder says, draw more naturalistically, and their proofreading skills also improve, because they see what's in front of their eyes, rather than what their conceptual minds think they're seeing. Profiled in *The New York Times Magazine* last summer in an article called "Savant For a Day," Snyder has captured the imagination of the press by predicting that someday, anyone will be able to don a TMS "thinking cap" and boost their creativity with

improvement on tasks at which savants typically excel, except for a small increase in a test related to long-term memory. Some skills actually declined slightly.

Treffert, who has been studying the minds of people like Matt for 40 years, is skeptical of Snyder's shortcut to accessing savantlike skills. "The likelihood of significant savant abilities emerging in a 10- or 20-minute TMS session in normal volunteers is, in my view, zero."

Oliver Sacks, whose books inspired Snyder to enter the field, visited the Centre for the Mind last year. Sacks' own session under the thinking cap, however – now immortalized in a photo on Snyder's Web site – lasted only a few minutes. "It gave me a headache," he recalls, "or rather, a face ache."

But Sacks' conversations with Treffert and Snyder have led him to reconsider his statement in *The Man Who Mistook His Wife for a Hat* that autistic savants are "a strange species in our midst, odd, original, wholly inwardly directed, unlike others." These days, Sacks is weighing the possibility that savants may be more like us than he thought.

"It's the isolation of powers in the savant that is so peculiar, but one might say the same about many people – particularly musicians. I now think that the presentation of great musical powers may be rather similar in the savant and in the future composer." The crucial difference, he adds, is that the musical gifts of savants "fail to develop in the same creative way" as the skills of future composers.

Sadly, in many cases, their gifts fail to develop at all. The artistic powers of a celebrated savant named Nadia – a British girl who began drawing at age 3 with more accuracy and subtlety than many adult

"When Matt was very young," his mother tells me, "it was difficult for me to imagine a future for him."

Matt's future as a musician will be determined by what is still a neurological mystery: creativity.

For most of the 20th century, intelligence was viewed as an all-purpose, monolithic power, christened *g* by psychologist Charles Spearman. Creativity was believed to be a side effect of a high level of general intelligence – a mark of big *g*.

The father of the standardized-testing industry, Lewis Terman, created the Stanford-Binet Intelligence Scale to quantify this power. He launched the longest scientific study in history, *Genetic Studies of Genius*, to track the accomplishments of highly gifted grade-school children through the course of their lives.

His hope that an impressive IQ score would augur groundbreaking accomplishments in science and art, however, didn't pan out. His young Termites, as he affectionately called them, did end up earning slots at better universities and getting hired for executive positions, often with help from Terman. They gave the world two memorable inventions: the K ration and *I Love Lucy*. (Both Ancel Keys, who perfected single-meal pouches for the US Army, and Jess Oppenheimer, the creator of the popular TV show, were Termites.)

For the most part, however, real genius slipped through Terman's net. None of his prodigies won major scientific prizes or became important artists, while two students excluded from the study for having insufficient test scores, William Shockley and Luis Alvarez, went on to earn Nobels.

modules of intelligence to highly tuned computational devices.

But, like Terman, Gardner missed something: the difference between computation and creativity. If a bottomless literal memory and a set of algorithms were enough to make us significant artists and composers, our iPods and museums would chronicle a history of savant breakthroughs. The computational abilities of savants may give them glimpses of the world as it really is, as Snyder says. But creativity is also the ability to imagine the world as it is not – to make conceptual leaps and refine the raw data of experience into abstract ideas, meaning, and insight.

That is precisely the function of the most recently evolved areas of the brain – the regions of the prefrontal cortex that are damaged or impaired in many savants.

Sacks maintains a personal shrine to creative intelligence over his desk in Greenwich Village. There, his friends smile from a collection of photographs: the chemists Roald Hoffman and Linus Pauling, the virologist D. Carleton Gajdusek, the playwright Jonathan Miller, the neuroscientist Vernon Mountcastle, and a 19-year-old wunderkind, Nick Younes, whom Sacks calls Big Nick.

"These people are very unlike savants," he explains. "They're people of great all-around g. One feels it strongly in the size of someone's universe, its depth and spaciousness, in their intellectual agility, and in the power of generalizing, which seems to cross all the particular modalities."

The mark of real genius is that it leaves its own domain permanently changed. After a century of dissecting the cortex into smaller and smaller bits, we're learning that the highest functions of the mind –

past, and find teachers like Katsenelenbogen. (I once asked Matt if he was familiar with Miles Davis' *Kind of Blue*. "Every jazzman," he sniffed, "knows *Kind of Blue*.") They also know when it's time to stop taking calls from talk-show bookers and just let him be a kid, at home among his melodies and his numbers again.

On a stage in Florida, Matt sits down at a piano in front of a sold-out audience to record an album called *Chasing Your Tail*. His trio takes liberties with seven original tunes and three standards – "Body and Soul," "Chelsea Bridge," and "My Favorite Things." As he plays, he rocks from side to side because his arms are too short to span the keys.

The notes pour out of him, as if they had a mind of their own.

GrEAtNess DiAgNosEd Are certain forms of creativity enhanced by brain damage? Do the same genetic traits that produce disorders like savant syndrome, autism, and Tourette's contribute to genius? Hans Asperger, who in the early 1940s pioneered the study of autism, believed the answer was yes. "For success in science and art," he wrote, "a dash of autism is essential." The biographies of many innovative thinkers bear him out. – S.S.

Thelonious Monk Jazz composer and improviser Possible diagnosis: Tourette's syndrome The high priest of bebop spoke in a medley of grunts and cosmic aphorisms and danced around his piano – and his ticcish syncopations blasted jazz out of the swing era.

Carl Friedrich Gauss Mathematician and astronomer Possible diagnosis: prodigious savant Gauss

freak in the studio. But when he sat down at the piano, he channeled Bach. Like many savants, he had absolute pitch and a steel-trap memory.

Samuel Johnson Writer and lexicographer Possible diagnosis: Tourette's syndrome Johnson, the author of the first English dictionary, was prone to ritualistic movements punctuated by outbursts of barnyard noises and fragments of the Lord's Prayer.

Andr�-Marie Amp�re Physicist and mathematician Possible diagnosis: prodigious savant A pioneer in the study of electromagnetism, Amp�re started calculating even before he could read numbers, working out complex formulas with stones and cookie crumbs.

Temple Grandin Professor of animal science Diagnosis: high-functioning autism Grandin designs more efficient and humane livestock-handling facilities by taking a cow's-eye view, using an autistic mode of cognition that she calls "thinking in pictures."

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