

DEEP DIVE

Extraordinary minds: The link between savantism and autism

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13 JANUARY 2016

Photographs by Patrick Fallon

“It don’t mean a thing if it ain’t got that swing,” Rex Lewis-Clack croons, his head joyfully bobbing in time with the Duke Ellington standard. The 20-year-old musician accompanies himself on a grand piano, deftly striking the keys with a dexterity reminiscent of the Duke himself. Then he segues into an exquisitely executed rendition of Chopin’s Fantaisie Impromptu. Lewis-Clack has the sweet-faced, blond good looks of a teen heartthrob. But the haunting melody that seems to flow from his fingertips is masterful. It fills the high-ceilinged living room of the Los Angeles beachfront condo he shares with his mother, Cathleen Lewis. After the last strains echo through the apartment, he rocks back and forth on the piano bench and flaps his hands in excitement, seemingly elated, and flashes a wide, triumphant smile.

This cherubic young man was born blind, due to a congenital condition called septo-optic dysplasia. He had serious cognitive disabilities as a child, and severe symptoms of autism: Even the faintest noises would make him scream, and he was so sensitive to touch that he kept his hands balled up in fists. “On his third Christmas, we had to go out of the room to open presents because he couldn’t stand the ripping sound of the wrapping paper,” recalls Lewis. “He wouldn’t eat solid foods and pretty much lived off liquids for his first few years. It seemed like he was a prisoner in his own body.” His doctors predicted he would never walk or talk.

When he was 2, Lewis-Clack’s father gave him a piano keyboard. It became his gateway to the outside world. Lewis-Clack taught himself to play the piano, says Lewis, “and would play until he dropped from exhaustion.” When he began formal lessons at age 5, his teacher noticed his remarkable gifts. Lewis-Clack has perfect pitch, a phenomenon that occurs in about 1 in 10,000 people: He can identify a musical note immediately, even when he hears it completely out of context. Although he cannot see and cannot read music, he only needs to hear most songs once to play them back perfectly. And he has whole libraries of music stored in his brain. “One day, Rex sat down and played through all 21 of Chopin’s nocturnes, and played them perfectly even though he had only studied or played six of them [before],” says Lewis. Unbeknownst to her, he had

memorized the other 15.

Lewis-Clack doesn't talk much, responding to most questions with short sentences. "I crack the eggs," he amiably offers when asked how he'll help his mom prepare a pumpkin pie for the holidays. He communicates mostly through his music: He played in his first concert at age 7 and now travels around the world to perform in fundraisers to benefit people with disabilities. Because of his exceptional musical talent and his intellectual disability, he is considered a savant — one of those unusual people who struggles with tasks that most people find simple, yet has extraordinary abilities that few could hope to attain.

Savant syndrome is a loose term that refers to people who have a combination of significant cognitive difficulties, often stemming from autism, and profound skills — "islands of genius," in the words of Wisconsin-based psychiatrist **Darold Treffert**, an independent scholar who has studied savants for more than half a century. Once thought to be rare in people with autism, found in no more than 1 out of 10 individuals, research over the past few years suggests savantism may be more common: As many as one in three people with autism may possess exceptional abilities.

Exactly how and why savantism happens is unclear. But some evidence suggests that savants may have experienced an undetected injury to the left hemisphere of their brain *in utero* or in infancy, triggering compensatory recruitment in the right brain that unleashes unusual abilities.

Most savants have special abilities in musical, artistic, mathematical or mechanical domains, coupled with extraordinary memory. Stephen Wiltshire, for instance, a British savant and artist who was diagnosed with autism at age 3, has been called a "human camera" because of his ability to draw landscapes from memory after seeing them only once. Other savants possess the uncanny skill of 'calendar calculating' — quickly computing the day of the week of any arbitrary date in the past or future — highlighted in the 1988 Oscar-winning movie "Rain Man." Still others may have a facility with foreign languages, the ability to measure distances or heights with precision without using instruments, or exceptional map-reading skills. But only a handful possess Lewis-Clack's extraordinary gift.

Ordinary genius:

Savants were described in the medical literature **as early as the late 18th century**, but the past few decades have provided a better understanding of the phenomenon. An **extensive survey in 1978** suggested the 1 in 10 estimate, and it became an article of faith.

In tune: Lewis-Clack and his mother, Cathleen Lewis, are constant companions.

But research in the past 10 years has generated some controversy about the actual incidence of savantism. Some researchers say these seemingly extraordinary abilities may just reflect the fact that many people with autism have a different skill set than their typical peers do. “People with autism are natural specialists — when they dig in, they quickly become expert,” says **Laurent Mottron**, a psychiatrist at the University of Montreal.

People with autism tend to **do poorly on standardized tests of intelligence** that have time limits and rely on verbal instructions, cultural familiarity and social interactions. Evaluations such as the Raven’s Standard Progressive Matrices, which measures reasoning and creative problem-solving, provide a better gauge of intelligence.

When researchers use these more appropriate methods of assessing intelligence, the peak abilities thought to be a sign of savantism — the ‘islands of genius’ in people believed to be profoundly impaired — disappear. “There is a bell curve in savantism, just like the bell curve of intelligence,” says Mottron. The high-scoring end of the bell curve in autism includes a few people whose exceptional abilities in certain domains exceed those of most people without autism.

This interpretation is in line with that of a 2009 study conducted by psychologist **Patricia Howlin** of the Institute of Psychiatry at King’s College London. In **that study of 93 individuals with autism**, parent reports and test scores indicated that 39 — roughly 40 percent — had exceptional skills, both in comparison with their other abilities and with skill levels found in the general population. Those abilities include what are called ‘splinter skills,’ such as the capacity to perform complex mathematical calculations mentally without pen and paper.

Howlin’s study included two different measures: The participants either had a ‘savant skill,’ such as superior mathematical, musical or artistic abilities, or a memory for dates, places, routes or facts, or they had ‘exceptional cognitive skill,’ defined as an intelligence quotient (IQ) two standard deviations above the mean score of 130. A few individuals fit both categories.

Traditional studies of people with autism may be skewed, Howlin points out, because many of the participants are from a self-selected population: the people who are referred to psychologists because of their severe deficits. Meanwhile, those with autism who are functioning well may be under-studied simply because they’ve integrated well into society and aren’t brought to the attention of researchers. “The trouble is that we don’t know an awful lot about people with autism who manage well in the world because we study the individuals who haven’t managed too well,” says Howlin.

“People with autism are natural specialists.” Laurent Mottron

Left vs. right:

Where the exceptional talents of people with autism stem from is an enduring mystery, but some of the puzzle pieces are starting to fall into place.

More than 30 years ago, pioneering San Diego psychologist Bernard Rimland developed the world’s largest database of people with autism, with more than 34,000 individuals. Rimland noticed that their savant skills, such as artistic expression or the ability to mentally manipulate three-dimensional (3D) objects, were most frequently right-hemisphere faculties. Their difficulties, such as trouble communicating, often appeared in functions controlled by the left hemisphere.

In many types of brain injury or in dysfunction caused by stroke or neurodegenerative diseases, doctors have noticed that a defect in the left hemisphere may lead to a compensatory improvement in typically right-hemisphere functions. It’s as if the injury is “releasing the brain from the tyranny of the left hemisphere,” in Treffert’s words. No longer held in check, right-hemisphere abilities appear to suddenly blossom.

Brain imaging provides glimpses into the mechanism underlying the emergence of these exceptional talents. Some early clues came from imaging studies of acquired savantism: ordinary people of average intelligence and ability who suffered a severe brain injury and suddenly developed new skills, such as musical talents, the ability to speak foreign languages, or superior skills in mathematics or art.

Bruce Miller, a neuroscientist at the University of California, San Francisco, witnessed this phenomenon firsthand when some of his elderly patients who suffered from frontotemporal dementia (FTD), a degenerative brain disorder that primarily affects the front left-side portion of the brain, **spontaneously developed an interest in art**. As the dementia progressed, these individuals became gripped by the urge to create, and their paintings improved.

Miller and his colleagues used single-photon emission computed tomography, a technique that captures blood flow changes in the brain and reflects neuronal activity, on a dozen people with FTD who had developed new artistic talents. The scans revealed damage to the anterior temporal lobe of their left hemisphere and the orbitofrontal cortex, regions associated with logic, verbal communication and comprehension. Miller and his team theorized that the selective **brain degeneration essentially ‘released’ dormant abilities** in the right brain, which is dominant for some key features of artistic expression, including visual construction — the ability to copy drawings or put puzzles together — and some forms of creative thinking.

When they compared these scans with those from a young artist with autism who had had a compulsive urge to draw since early childhood, the researchers found “remarkable parallels.” Like the people with FTD, the **9-year-old savant** showed loss of function in the left temporal lobe, paired with heightened activity in regions of the right brain that process sensory inputs and visual information.

Imaging studies by Mottron’s team and others shed more light on savantism’s possible neurological underpinnings. Mottron’s group has found that people with autism who have average IQ scores are **nonetheless up to 40 percent faster** than their peers without autism at solving complex logical problems. Their analytical skills may account for this superiority in manipulating numbers. The team has also found that people with autism possess **enhanced perceptual abilities**: They excel at discerning patterns against the backdrop of complex environments, spotting embedded details that others miss, and often have exceptional ability in mentally manipulating 3D shapes.

In a 2012 meta-analysis of functional imaging studies, Mottron’s group found **enhanced activity in people with autism** in brain regions associated with visual processing, object recognition, visual imagery and visual expertise, the ability to differentiate between similar objects — for example, different types of birds. “These results suggest that enhanced reliance on visual perception has a central role in autistic cognition,” says Mottron.

Famously, the well-known animal behavioral scientist **Temple Grandin**, who was diagnosed with autism as a child, has said that she “**thinks in pictures.**” She says her acute vision enables her to notice details that most people gloss over but animals detect and may be frightened of, such as shiny objects that reflect the sun’s rays. This heightened visual processing helps her in her work designing low-stress environments for livestock.

Different drummer: When Lewis-Clack was a baby, doctors predicted he would never speak.

Mottron says enhanced perception may contribute to logical ability, which might explain the superior skill of some people with autism in solving complex logical puzzles. Heightened perception could also aid in the acquisition of three abilities associated with savants: perfect pitch, hyperlexia — precocious reading ability in a very young child — and **synesthesia**, a condition in which sensory stimuli is jumbled so that hearing a sound might produce a visualization of a color. Mottron’s team summed up all these changes as the “functional re-dedication of perceptual brain regions to higher-order cognitive functions” — in other words, the brain seems to redeploy its resources, so that regions normally engaged in one purpose are recruited to take on more advanced tasks.

Essentially, what this means is that the brains of people with autism are more flexible than those of their peers. (This ‘plasticity’ doesn’t help them overcome their social deficits, however, because the intricacies of social interactions cannot usually be processed perceptually or logically, Mottron says.) In general, people with autism recruit different neural pathways than controls do to accomplish a particular task. They also may have more activity in regions associated with perception. In the same way that losing one sensory faculty, such as eyesight, may prompt the brain to compensate by reallocating more neural resources to produce exceptional hearing ability, the brains of people with autism may be better able to reorganize. That leads to enhanced perception; if that faculty is combined with knowledge and other forms of expertise, the result is savant skills. This, Mottron says, may be our best hint as to how savant abilities are acquired.

“Autism and savantism may have a common genetic root.” Joanne Ruthsatz

Chance encounter:

In 1998, **Joanne Ruthsatz**, then a graduate student in psychology, stumbled upon a possible explanation of the roots of savantism during a chance meeting in a fast food joint in southern Louisiana. She had traveled to the bayou country to interview a 6-year-old musical prodigy who was playing guitar at music festivals across the South. After undergoing a battery of IQ and aptitude tests, all the guitar phenom wanted to do was go to McDonald’s. So the trio — the boy, his mother and the scientist — trooped out to the local hamburger emporium. “Just by chance, the child’s aunt and his teenage cousin came in,” Ruthsatz recalls. “While the two sisters talked, the cousin grunted and flapped his hands. Later, the mother told me her nephew had severe autism. And I thought: What are the chances of them being first cousins like that?”

As it turned out, the odds are quite significant. In a 2007 study, Ruthsatz distributed the Autism Spectrum Quotient, a test devised by British researchers to measure traits associated with autism, to three sets of people, each including 10 individuals: One group included prodigies and their first-degree family members (parents or siblings), another included individuals with autism and their family members, and the third included individuals without any diagnoses and their family members. The prodigy families and the families of those with autism both scored higher on traits associated with autism, including difficulty with social skills, difficulty switching attention (the ability to multitask), and enhanced attention to detail. Because individuals with autism are often keenly attuned to seemingly extraneous details, Ruthsatz found it especially interesting that the prodigies outscored them on this characteristic.

Since that fateful meeting, Ruthsatz, now a psychologist at Ohio State University in Mansfield, has collected extensive profiles on 30 children who were deemed prodigies (she identified them through the Internet, via press attention and by referral). By the end of 2011, she had discovered

that three of the first nine prodigies she investigated had been diagnosed with autism early in life but no longer met the criteria. “They no longer qualified for a spectrum diagnosis,” says Ruthsatz. What’s more, five of the nine had at least one close family member with autism. One prodigy had two siblings, a father, grandmother and an aunt on the autism spectrum. “It means that the two conditions may have a common genetic root,” says Ruthsatz, coauthor of the upcoming “**The Prodigy’s Cousin: The Family Link Between Autism and Extraordinary Talent.**”

Further research added detail to the earlier findings. In a 2012 study of **eight prominent child prodigies**, Ruthsatz documented many characteristics that are often found in children with autism, such as difficulties in social settings and obsessive attention to detail. The prodigies also had remarkable skills in working memory — the ability to manipulate information stored in short-term memory banks — scoring two standard deviations above the mean. Six out of eight of the prodigies scored in the 99.9th percentile.

In 2015, Ruthsatz’s team identified a **potential genetic link** between prodigies and people with autism. In genetic samples from 11 prodigies and from the family members of people on the autism spectrum, they discovered a common mutation on chromosome 1, in a region known as 1p31-q21. The research team has yet to pinpoint the exact location of the genetic variant, and as yet has no theories about how the variant may contribute to some of the characteristics shared by prodigies and savants. The team is searching for a genetic modifier in the prodigies that might be protective against autism, which might explain why they no longer have the diagnosis.

In the meantime, scientists and the public alike continue to be fascinated and inspired by people such as Rex Lewis-Clack, who straddles the world of the prodigy and the savant.

Listen up: Lewis-Clack has perfect pitch and an exceptional memory for songs.

In 2013, Lewis-Clack and his mother launched a foundation for after-school programs for blind children with autism in southern California. His mother talks about all the things he has done, such as performing at fundraisers for Best Buddies International, serenading Vice President Joseph Biden and his family at their Washington, D.C., residence for a reception honoring Eunice Kennedy Shriver, and being greeted like a rock star at a music festival in Freiburg, Germany, where the whole town turned out to hear him play. “That made me feel great,” Lewis-Clack says, beaming. The affable young man spends most of his days immersed in music, taking voice and piano lessons and learning improvisation techniques.

Lewis-Clack’s gifts transformed him from a timid toddler into a celebrated performer who plays to

packed houses at concert halls throughout the world. After the Chopin, I ask him if he would play another tune. “No,” he responds, firmly but not in an unfriendly way. I ask his mother if it would be okay to ask if I can give him a hug as a way of expressing my appreciation for the mini-concert, and she smiles and nods vigorously. Lewis-Clack rises from the piano bench, arms open wide, and gently envelops me, as if it’s the most natural thing in the world.