THE INNER SAVANT
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When Nadia was born there was no indication she was anything special. But as she grew it was apparent something was amiss. She avoided eye contact and made no emotional response whether her mother smiled or cooed—she didn't even recognize her mother. She was oblivious to words spoken to her, and herself uttered only a few words. She was unusually clumsy for a child her age, and played in repetitive ways, tearing paper into strips.

Then at the age of three and a half, she picked up a pen and began to draw. Not scribble, but *draw*. Photograph-like sketches of galloping horses that only a trained adult could equal.

If Nadia's drawings were awe-inspiring, then so was the experience of watching her create them. Her clumsiness fell away as she made her first deft strokes with the pen. A typical person would begin with the outline of the horse, but Nadia began with apparently random details. First a hoof, then the horse's mane, then its harness. Only much later would she lay down firm lines connecting these floating features—but when she did connect them, they were always in the correct position relative to one another.

Nadia was an autistic savant. A child with the severe mental and social deficits that typify childhood autism, but at the same time with a mysterious talent that spontaneously appears—usually between ages 2 and 6—a talent that puts you and I to shame.

Truly phenomenal savants like Nadia are exceedingly rare. They exist on the periphery of popular consciousness, and along with ball lightning, crop circles and Area 51, are dismissed as inexplicable curiosities.

The most famous savant is Joseph, whom Dustin Hoffman portrayed in the 1987 movie *Rain Main*. Joseph could instantaneously answer the question, "what number times what number gives 1,234,567,890"—his answer was "9 times 137,174,210." Another savant could double 8,388,628 up to 24 times within several seconds to obtain the ungodly number 140,737,488,355,328. Yet another, when awoken in the middle of the night, knew the time to the minute. Meanwhile, at the age of six, Trevor listened to his older brother play the Piano, and then climbed onto the stool himself and played it better. And finally,

whenever was Eric in a room with music playing from multiple speakers, he would find what he called the room's "sweet spot," where all the music from the different sources hit his ears at *exactly* the same time.

While the bizarre stories continue, the most accepted explanations are less than bizarre: most researchers essentially chalk them up to compulsive learning.

But Allan Snyder, a vision researcher and Director of the Centre for the Mind at University of Sydney and Australia National University, has advanced a more mind-blowing proposal. "Each of us," says Snyder, "has the innate capacity for savant-like skills. But that mental machinery is unconscious in most people." Normal humans are conceptual thinkers, more interested in recognizing a face or recalling the overall gist of a conversation than in recalling the minute details of either. But in savants, says Snyder, this top layer of conceptual thinking is stripped away, giving them conscious access to what lays below—a starting capacity for lightning-quick calculations and remembering endless detail. These unconscious abilities provide the raw material for conceptual thinking. But now that Snyder believes savants have easy access to them, he's developing technologies to allow any normal person to do the same.

What happens in the autistic brain to produce savant talents remains a mystery. During the first three years of life, growth of the autistic brain accelerates and neurons connect haphazardly, causing widespread abnormalities. The result is a tendency not to explore one's wider environment and to have narrowed fields of attention—for example, examining only one part of a face without seeing its overall expression. Autistic children also have altered facial recognition—their pattern of brain activation when they see a familiar face is vastly different from that in average people.

A failure to explore the environment produces repetitive behaviors like chair-rocking, and narrowed interests such as vacuum cleaners or washing machines—or maybe even drawing horses. Many autism researchers suspect anyone who quit their job and practiced long enough could develop savant-like skills. "If that's possible, then maybe savant skills just reflect one form of repetitive behavior," says Eric Courchesne, Director of the Laboratory for Research on the Neuroscience of Autism at the University of California – San Diego.

In sum, autism researchers have long viewed savant skills as a phenomenon of compulsive practice. But Snyder was not a member of this field. Instead, this was the hostile landscape that his alien space capsule crashed into when he published his theory in 1999.

"Everyone in the world was skeptical," says Vilayanur Ramachandran, Director of the Center for Brain and Cognition at University of California – San Diego. "[But]

Snyder deserves credit for making it clear that savant abilities might be extremely important for understanding aspects of human nature and creativity."

One has to wonder what lured Snyder into the field of autism and put him on a radical collision course with the ideas that were already established there. I wanted to hear that story, so I visited him in Australia.

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The Centre for the Mind offices at University of Sydney reside in a far-flung gothic building, complete with pointed towers and notched battlements. Inside it's spotless and modern. Nadia's horse drawings adorn the walls of Snyder's office, while works by other savants—a yacht here, a haunting medieval tower there—adorn other rooms, including the restroom. It's into this refined setting that I arrive a tad late from my mid-day foray to an experimental wallaby colony, acutely conscious that I carry the dung of seven species of rock wallaby fresh and aromatic upon my heels (such is the life of a science writer).

As for Professor Snyder, the tufts of white hair on either side of his head might give him that mad scientist look—and how appropriate for a man who wishes to tap into primal, subconscious faculties of the brain which he himself admits would delight Freud. But his personality contains no such dark elements. He speaks of his work with a boyish enthusiasm, as though showing a grandparent a model airplane, and the red baseball cap he wears today is disarming.

Snyder's ideas began evolving in 1987 during a sabbatical to Cambridge, England. He was by Ramachandran's recent work—using optical illusions to show how the brain uses shortcuts to transform the mountain of information that falls on the retina into something simpler and more useful. Ramachandran had demonstrated the brain derives 3D shape from shading, assumes all light comes from one source, and when the light source is uncertain assumes it comes from above.

"You're not aware how your mind comes to those conclusions," says Snyder. "When you look at a ball, you don't know why you see it as a ball and not a circle. The reason is, your brain is extracting the shape from the subtle shading around the ball's surface." Every person's brain possesses that innate ability, yet only artists can do it backwards, using shading to portray 3D shape.

"Then," says Snyder, leaning toward me and speaking slowly to emphasize his point, "I asked the question that put me on a 10 year quest. How can we access our non-conscious processing, and in so doing see the world in its raw rather than conceptual form?"

The answer came several years later when Snyder read about Nadia. As he sat in his apartment one afternoon in Sydney with the book in his hand, gazing across Elizabeth Bay, an idea surfaced. Perhaps an abnormal brain like Nadia's that lacked conceptual thinking might provide a conscious window to the mountain of mental processing below.

Snyder's theory began with art, but he now believes all savant skills derive from one source, a lightning-fast processor in our brain that equipartitions, or divides things into equal parts. Dividing time might allow that savant child to know the time when he's woken, and it might help Eric find the "sweet spot" by allowing him to sense millisecond differences in when sound hits his ears. Dividing space might allow Nadia to place the disembodied hoof and mane on the page in precisely the right positions. It might also have allowed two savant twins to instantaneously count matches that were spilled on the floor (one said, "111," the other said, "37, 37, 37"). Meanwhile, splitting numbers might allow math savants to factor 10-digit numbers, or easily identify large prime numbers, which *can't* be split.

In responding to claims that compulsive practice alone produces savant skills, Snyder cites rare cases of sudden-onset savantism, where a previously-normal person emerges from a serious brain injury with new skills. Take Orlando Serrel, who at the age of 10 was hit in the head by a baseball, and six months later could easily recall license plate numbers, song lyrics and weather reports.

"Snyder's ideas sound very new age—this is why people are skeptical," said Ramachandran when I spoke with him on the phone a few days later. "But I have a more open mind than many of my colleagues, simply because I've seen [these sudden-onset cases] happen." Ramachandran particularly recalls the case of a physician who developed a flare for poetry when he began having epileptic seizures.

And patients with frontotemporal dementia (FTD), a degenerative brain disease that strikes people in their 50s and 60s, frequently develop are and music skills. University of California – San Francisco neurologist Bruce Miller has done MRI and other brain imaging studies revealing that most of the FTD patients who develop skills suffer more damage on the left, or dominant side of their brain. Since this side supports language, these people gradually lose speech, reading and writing. They also lose face recognition. Meanwhile, their right brain, which supports visual and spatial processing is better preserved.

"They really do lose the linguistic meaning of things," says Miller, who believes Snyder's ideas fit nicely with FTD, "There's a loss of higher-order processing that goes on in the anterior temporal lobe." In particular, FTD patients suffer damage to the end of their ventral stream, an anatomical element that answers the

'what?' question in visual recognition. More importantly, Miller has also performed brain imaging studies on one autistic savant artist, D.B., who began drawing horses at the age of 18 months. What he found was surprisingly similar to FTD artists: the abnormality was greater on the left anterior temporal lobe than on the right.

The sun is setting, and I'm about to leave Snyder's office, but I want to clarify what he means about autistics seeing the world as it really is. So I recount a memory from college. A lurid, sleep-deprived memory of a solo drive across the country which culminated in an all-nighter on the Pennsylvania turnpike. Around 3am, shortly before I stopped for a nap, my vision—or my understanding of what I saw—deteriorated. Stripes painted on the road stood vertically. The two headlights of an oncoming truck belonged to two different vehicles. Worst of all, it became difficult to know which pair of reflective posts to drive between—the pair formed by two posts on either side of the road, or the pair formed by two posts on the same side of the road.

"Your concept machines weren't working," replies Snyder. "That's what I think autism is." Of course I was in no shape to draw lifelike sketches of galloping horses or recite the weather from March 4, 1976, and herein lies an important point. Autistics show a wide variety of different (if overlapping) brain abnormalities. It's partly the details of those abnormalities—what's missing and what's not—that determine whether they spend their time flicking their hand or multiplying 10-digit numbers.

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I wanted to meet a savant, so on a blustery, rainy Thursday morning I drove to Mansfield, a small farm town 300 kilometers northeast of Melbourne.

The three hour drive pitched and rolled through hills, occasionally cutting through dense eucalyptus forests punctuated with yellow koala-crossing signs. And here and there in the farmlands were the large, white-crested parrots that inhabit the area. Usually one or two in a front yard, although once I saw a flock of a thousand or more—an unforgettable, unphotographable sight—wheeling about in the air like a galaxy.

My goal was Acorn Outdoor Ornaments, a one-story house on the edge of town where a ceramic dwarf on the roof greets visitors and a group of autistic adults learns independent living skills and creates lawn ornaments that can be had for a reasonable price.

Many non-savant autistics also have significant islands of ability, and Joan Curtis, the psychologist who runs Acorn, has done an excellent job of cultivating these

talents as a means of encouraging social interaction. But I was hoping to meet a couple of standouts at Acorn. One was Guy, who was uncomfortable shaking my hand, but is fascinated by all things electronic, and avidly questioned me about my tape recorder. Entering Guy's room was one of the two truly memorable moments of that day.

Things he'd built crowded every horizontal surface. An electric fan with a metal alligator mouth on the front that opened and closed as it pivoted side to side. Another fan with a metal fisherman whose pole raised and lowered with each pivot. And finally, the sheep. Viewed from the left it was indeed a sheep covered in wool. Viewed from the right, a complete sheep skeleton that Guy had reassembled without visual aid. Guy, who cannot read or do arithmetic, has also built an electric dog model that barks, pants, wags its tail and urinates, and a music box that plays *Mary had a Little Lamb*.

The other striking moment occurred as everyone sat around the table painting. Tim, the other savant I hoped to meet, blew into the room like a surprise guest on Johnny Carson.

He was in a hurry to leave again, but asked me my birthday—July 15, 1970.

"Born on a Wednesday—eh?" he responded nonchalantly, as he opened the door to leave.

"How did you do that?" I asked.

"I did it well," he replied.

"But *how*?" I asked.

"*Very* well," he replied, with obvious pleasure. Then he was out the door, and he was gone.

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It's easy to understand why people propose exotic explanations for savant talents, especially when savants themselves cannot say how they do it. But the reality isn't as clear-cut as the glimpses we get from pop culture would lead us to believe.

My observation from Acorn is that autistic people are difficult to interview. They suffer metaphor deficiency, and interpret things literally. And as a journalist, you want to ask open-ended rather than leading questions, but if you do, you get dead-end answers. When I asked Guy where he obtained the sheep bones, he

said he dug them up. End of story. Later, someone told me he'd *also* buried the sheep.

I don't know how Tim knew I was born on a Wednesday. But several years ago University of California – San Diego cognitive psychologist Timothy Rickard evaluated another calendar savant. This 40 year old male with a mental age of 5 could assign day of week with 70% first-guess accuracy. There were clues to how he did it. Since he was blind from birth, he couldn't visually study calendars or picture entire calendars in his mind. And since he couldn't even do 4+3 arithmetic, he couldn't use a mathematical algorithm. Finally, he could only do dates falling within his lifetime, suggesting he used memory.

He was, however, able to do day of week arithmetic within a 6 day range ('if today is Wednesday, what day is two days from now?'). Rickard suspects that if he memorized as few as 2,000 dates, and used day of the week arithmetic, he could achieve his 70% accuracy. "That doesn't reduce it to a trivial skill," says Rickard, "But it's not inconceivable that someone could acquire this performance with a lot of effort and of social support."

This doesn't explain every calendar savant—Tim calculates dates as far back as 1900 as well as into the future, and two twins could calculate dates up to 40,000 years in the past or future. But other mundane explanations may apply in other cases. Robyn Young, an autism researcher at Flinders University in Adelaide, Australia, says some calendar savants study perpetual calendars several days a week (there are only 14 different calendar configurations; perpetual calendars cross-reference them to years). Practice may augment other savant skills, too. When I visited Robyn's office, she dragged out page after page of autistic doodling: factoring and multiplying of three digit numbers, drawings of power lines, telephone poles and trains—page after page, day after day.

But even if savants practice, this doesn't necessarily mean they're not tapping into a universal ability like Snyder has proposed. Here it helps to consider art savants.

That Nadia began drawings with minor features rather than overall outlines suggests she perceived individual details more prominently than she did the whole—or the concept—of what she was drawing. Other savant artists draw the same way. It's also tempting to speculate that Nadia's inability to recognize her own mother despite normal eyesight indicates a lack of conceptual thought.

Another interesting observation is that normal children experience added difficulty when they're copying an "impossible" picture such as an M.C. Escher drawing where water flows both up and down. Autistic children don't, dovetailing

with Snyder's idea that the conceptual machinery of an autistic child is out of the loop.

These are mere observations. But what's truly thought-provoking is what I learned when I visited the studio of Guy Diehl—a *non*-savant artist who lately is known for his series of crystal-clear still-life paintings of stacked books, drafting implements and fruit.

Even accomplished artists sometimes employ tricks that put them momentarily into a more concept-free, savant*esque* frame of mind. When Diehl hits a sticking point on a painting, he may actually view it in a mirror, or upside down. "It reveals things you otherwise wouldn't see," he says, "because you're seeing it differently—you're almost seeing it for the first time again." Anyone who doubts that viewing things upside down or in the mirror muddles the brain's concept- and symbol-processing should try reading this story upside down or in the mirror (letters, after all, are symbols).

Art students are taught realistic drawing using similar methods. Before I left, Diehl, who taught art for 18 years, had me draw a pair of scissors that he placed on the table—but specifically instructed me to draw the negative space around the scissors, not the scissors themselves. As I drew the place where the empty space disappeared behind the scissors, I realized I was looking at something for which we have no word. More importantly, I felt I was drawing individual lines, not an object. The my drawing wasn't half bad, either.

Drawing exercises are a mild way of telling one's conceptual machinery to take five, but more persuasive methods are available. After publishing his theory, Snyder publicly uttered yet another *modest proposal*: that with a technique called transcranial magnetic stimulation (TMS), one could use magnetic fields to knock out a normal person's conceptual brain machinery, temporarily transporting them to a savant-like state.

Young and her colleague Michael Ridding of the University of Adelaide actually tried it. Using TMS on 17 volunteers, they inhibited the left anterior lobe—the language and concept-supporting brain region that's disrupted in the FTD patients and the art savant that Miller studied. Under TMS, the volunteers performed savant-like tasks—horse drawing, calendar calculating and multiplying.

Five of the 17 volunteers did improve—not to savant levels, but no one expected that, since savants practice. Furthermore, TMS isn't a terribly precise tool for selectively targeting brain regions, but the five volunteers who improved were those in whom separate neurological assessments indicated that the left anterior lobe was successfully targeted. "Obviously I don't think the idea is so outlandish

anymore," comments Young, "I think it is a plausible hypothesis. It always was, but I didn't expect we'd actually find the things we did."

Meanwhile, Snyder is doing his own experiments—not just to prove his theory, but with a larger goal. "We want to enhance conceptual abilities," he says, "and on the other hand remove them and enhance objectivity."

He imagines a combination of hardware and training. If drawing exercises succeed, what if the person being trained were hooked up to an EEG? Watching their brain waves, they could tell when they'd shut down their own conceptual machinery, and could learn to reach that state reliably. The training seems tame enough, but the hardware—perhaps a form of TMS—sounds decidedly sci fi.

"I envisage the day," says Snyder, "when the way to get out of a [mental rut] is you pick up this thing—those of us with jobs that demand a certain type of creativity—and you stimulate your brain. I'm very serious about this."

There have been times as I wrote this story when I could have used Snyder's brain gizmo. But then again, maybe I shouldn't be lured into a false sense of security by that red baseball cap—after all, would you let a mad scientist zap *your* brain?