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## How to grow a super-athlete

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This story could begin in many places — it's about beginnings, after all — but I'd like to start with the recent evening when my 4-year-old daughter, Zoe, appeared before me wielding a yellow baseball bat and an important announcement: batting tees were for babies. From now on, she would hit real pitches, like the big kids.

By way of biography, I should mention that Zoe, the youngest of four, is considered one of the finest all-around mini-athletes in the history of our house. She's widely celebrated for her ability to throw balls really far, to hop on one foot across the whole front porch, and to run faster than a superfast airplane can fly. So as I walked (and she raced) down to the basement and located an inflatable purple ball, I fully expected Zoe to take to hitting like she'd taken to everything else.

But Zoe, it turned out, pretty much stunk.

Toss after toss, she missed. Five tosses. Then 10. I tried throwing the ball softer, harder, lower, higher. I got a different bat, offered advice and abundant encouragement, tried covertly to pitch the ball so it hit the bat. Nothing worked. Zoe whiffed with virtuosity and enthusiasm. Against my nobler instincts, I found myself, like the purple ball, getting a bit deflated. I felt as if I were receiving a grimly polite report suggesting that Zoe, despite her athletic promise, had regrettably tested negative for hand-eye coordination.

A few days later, we did it again. This time Zoe started off missing, then hit a foul ball. Then two fair balls in a row. Then three. She was watching the ball now, timing it. As the saying goes, something had clicked. Zoe hit the last toss squarely, and the purple ball zipped past my ear and smacked the window with a resounding gong. We froze at the unexpected sound, enjoying the moment and the question echoing beneath.

What, exactly, just happened?

What is talent? It's a big question, and one way to approach it is to look at the places where talent seems to be located — in other words, to sketch a map. In this case, the map would show the birthplaces of the 50 top men and women in a handful of professional sports, each sport marked by its own color. (Tennis and golf handily rank performance; for team sports, salaries will do.) The resulting image — what could be called a talent map — emerges looking like abstract art: vast empty regions interspersed with well-defined bursts of intense color, sort of like a Matisse painting.

Canada, for instance, is predictably cluttered with hockey players, but significant concentrations also pop up in Sweden, Russia and the Czech Republic. The United States accounts for many of the top players in women's golf, but South Korea has just as many. Baseball stars are generously sprinkled across the southern United States but the postage-stamp-size Dominican Republic isn't far behind. In women's tennis, we see a dispersal around Europe and the United States, then a dazzling, concentrated burst in Moscow. [Video More Video »](#)



The pattern keeps repeating: general scatterings accompanied by a number of dense, unexpected crowdings. The pattern is obviously not random, nor can it be fully explained by gene pools or climate or geopolitics or Nike's global marketing budget. Rather, the pattern looks like algae starting to grow on an aquarium wall, telltale clumps that show something is quietly alive, communicating, blooming. It's as though microscopic spores have floated around the atmosphere in the jet stream and taken root in a handful of fertile places.

A quick analysis of this talent map reveals some splashy numbers: for instance, the average woman in South Korea is more than six times as likely to be a professional golfer as an American woman. But the interesting question is, what underlying dynamic makes these people so spectacularly unaverage in the first place? What force is causing those from certain far-off places to become, competitively speaking, superior?

In early December, I traveled to the heart of one of those breeding grounds, the Spartak Tennis Club in Moscow. Russia is the birthplace of a group of athletes who have affected the World Tennis Association rankings in the same way that zebra mussels have affected the Great Lakes — which is to say, pretty much clogged them. The invasion happened swiftly: at the end of 2001, Russia had one woman (Elena Dementieva) in the W.T.A. Tour's top 30. By the start of 2007, Russian women accounted for fully half of the top 10 (Dementieva, Maria Sharapova, Svetlana Kuznetzova, Nadia Petrova and Dinara Safina) and 12 of the top 50. Not to mention 15-year-old Anastasia Pavlyuchenkova, who was the International Tennis Federation's No. 1-ranked junior and who was joined in the top 500 by five countrywomen also named Anastasia.

Spartak, usually preceded in the tennis press by the word "famous" or "legendary," had produced three of the top six Russians (Dementieva, Safina and Anastasia Myskina), along with Anna Kournikova, now retired. Tournament pairings regularly became all-Spartak affairs, most memorably the 2004 French Open final, Myskina over Dementieva, the continuation of a rivalry the two began at age 7. To put Spartak's success in talent-map terms: this club, which has one indoor court, has achieved eight year-end top-20 women's rankings over the last three years. During that same period, the entire United States has achieved seven.

"They're like the Russian Army," says Nick Bollettieri, the founder of the Nick Bollettieri Tennis Academy in Bradenton, Fla., and the former coach to Sharapova, Andre Agassi and other top-ranked players. "They just keep on coming."

Getting to Spartak, however, takes more than a talent map; it's not located on any real maps. Fortunately, help arrived in the form of Elena Rybina, a chain-smoking, speed-talking translator who worked part-time for the Russian Tennis Federation and who possessed a fast-alternating combination of film noir toughness and childlike giddiness that I took as the quintessence of modern Russia.

"I learned my English listening to music, like Elton John," she said. "'Crocodile Rocks!' I love it!"

We rode the subway half an hour northeast to Sokolniki Park and started walking. And walking. Sokolniki is almost twice the size of Central Park, considerably less central and only vaguely parklike. It's basically a huge forest of birch and elm trees filled with a disconcertingly energetic population of stray dogs. We walked past an abandoned chess club, an abandoned amusement park, an abandoned factory and the smashed onion dome of what appeared to be an abandoned church.

"It is very beautiful in summer," Rybina assured me as we passed a pond frosted with green scum. "But Spartak, I must warn you, is not so nice."

"What do you mean?"

Rybina lighted a Davidoff cigarette and raised her eyebrow into a Gothic arch. "Spartak is not exactly like a palace."

We turned a corner, followed a road for a few hundred yards and saw a loose assortment of peaked buildings and shotgun shacks that resembled a dilapidated ski village. Windows were dim cataracts of warped plastic, paint was scabbed and peeling and the buildings were frescoed in a rich coat of grime. A glaze of ice coated the club's 15 outdoor clay courts, as it did for six months of the year. A beat-up 18-wheeler lent the scene a postnuclear, "Mad Max" vibe. The only bright color came from the rainbow sheen of diesel fuel in the puddles.

Rybina shrugged indifferently and lighted another Davidoff. We walked past the inexplicably manned guard post, past an A-frame that appeared to be a storehouse for scrap metal and toward a larger

structure that resembled a greenhouse. We ducked through a low door and onto the court. The surface was worn down in frequently trodden spots, like cathedral steps. Two wooden sticks nudged the sagging net futilely toward regulation height. The fluorescent lights buzzed. "We are lucky," Rybina whispered. "The heat is working." When it doesn't, the kids play in their coats. 1

The class, called the Little Group, had already arrived. They wore heavy coats and toted their tennis rackets in backpacks, sports duffels and plastic grocery bags. At first glance, they looked like a standard-issue assortment of 5- to 7-year-olds: there was Denis, the handsome blond in the blue turtleneck; Alexandra, the lanky towhead in the green T-shirt; Gunda, the smiley ponytailed girl in the silver shoes; and Vova, the revved-up boy with the Asiatic eyes who was the class's only 4-year-old. There were 12 students in all. They had been coming to Spartak three times a week since September; by now they'd been on the court perhaps 40 times. As the lesson began, a few of them made their final preparations, reaching into their bags for what appeared to be their good luck charms: a tidy gallery of stuffed dinosaurs, bunnies and pandas formed on the wall behind the base line.

The coach, 77-year-old Larisa Preobrazhenskaya (pronounced pray-oh-brah-ZHEN-skya), stood at the sideline, watching. She wore a red-and-white tracksuit and a knowing, amused expression. Preobrazhenskaya was Spartak's most renowned youth coach, but she wore her authority lightly, radiating a grandmotherly twinkle behind hooded eyes. She'd been quite a player in her day, the 1955 Soviet singles champion. She still looked athletic, sauntering around the court with a John Wayne limp caused by a sore hip. The parents huddled by the door, watchful and silent.

The students formed a circle on one side of the net and started to stretch. I watched, scoping for telltale signs of überkinder superiority, but saw nothing of the sort. The Little Group proceeded to hustle energetically through a 15-minute set of calisthenics worthy of Jack LaLanne: jumping jacks, hops, crab walking, bear walking, skipping, sidestepping, zigzagging through a line of orange cones. I was half expecting them to pull out medicine balls, when they actually did pull out medicine balls, passing them back and forth earnestly like so many extras in a Rocky movie.

"All the motions," Preobrazhenskaya would tell me. "It is important to do everything, every practice."

The Little Group paired off with rackets and began imitatsiya — rallying with an imaginary ball. They bounced lightly from foot to foot, they turned, they swung, the invisible balls flew. Preobrazhenskaya roamed the court like a garage mechanic tuning an oversize engine: realigning a piston here, tightening a flywheel there. Several times, she grasped their small arms and piloted their bodies through the stroke. Thus the lesson began, and with it the unspoken implication: the great, rusty Spartak machine was coming to life, carrying its cargo of mini-geniuses another step closer toward inevitable glory.

As I pictured the scale of the David and Goliath phenomenon this unlikely scene embodied, the question arose: how does Spartak do it?

Explanations were not in short supply. I'd heard plenty from American tennis coaches, a nicely bulleted list that included a Slavic gene pool that produces a seemingly inexhaustible supply of tall, fast, strong kids; the economic and cultural gateway that opened with the 1991 collapse of the Communist government; the former Russian president Boris Yeltsin's enthusiastic (if at times klutzy) love for the sport; and the potent catnip effect of Kournikova, the former top 10 player who, though she never won a singles tournament, provided an escape-hungry generation of girls (and, more important, their parents) with vivid proof that tennis success equaled glamour, fortune, fame.

The Russians, when I asked them, chimed in with explanations of their own, including the lifelong commitment of coaches like Preobrazhenskaya; the superior biomechanical techniques taught at the Moscow Institute of Physical Culture, where many of Russia's top coaches train; and (in a nostalgic burst of cold war trash talking) the intrinsic softness of the West.

Watching the Little Group play, I, too, felt a strong urge to bellow my share of theories: it must be the medicine balls! The discipline! The lack of Game Boys! I was particularly struck by the kids' obvious enjoyment of the lesson. One of the mothers told Preobrazhenskaya that her daughter, Gunda, had awakened early that day, unable to sleep. "Today is my day with Larisa Dmitrievna!" Gunda had said. "It is today!"

In sum, there are a lot of explanations, some better than others. For instance, is the Russian gene pool really that innately superior to that of Ukraine or Slovenia or Southern California? If Kournikova inspired so many Russians, then where were the German stars inspired by Steffi Graf? But ultimately the theories fall short because they don't explain the principles underpinning Spartak's success.

Indeed, seeing the place up close made me wonder if there were any principles. Spartak radiates the glow of happenstance, the diamond in the trash heap. (This impression is apparently shared by the Russian Tennis Federation, which has been content to allow Spartak to remain with its single indoor court.)

So even here, at the core of one of the globe's brightest talent blooms, the question of that talent's source remains enigmatically tangled, perhaps as much of a mystery to those who nurture these athletes as it is to the rest of us. It's enough to make you wish for a set of X-ray glasses that could reveal how these invisible forces of culture, history, genes, practice, coaching and belief work together to form that elemental material we call talent — to wish that science could come up with a way to see talent as a substance as tangible as muscle and bone, and whose inner workings we could someday attempt to understand.

As it turns out, that's exactly what's happening.

I was peering inside an incubator at the Laboratory of Developmental Neurobiology at the National Institutes of Health in Bethesda, Md. The incubator, about the size of a small refrigerator, held shiny wire racks on which sat several rows of petri dishes containing clear pink liquid. Inside the liquid were threadlike clumps of mouse neurons, which were wired to platinum electrodes and covered with a white, pearlescent substance called myelin. Within that myelin, according to new research, lies the seed of talent.

"In neurology, myelin is being seen as an epiphany," Douglas Fields, the lab's director, had told me earlier. "This is a new dimension that may help us understand a great deal about how the brain works, especially about how we gain skills."

The myelin in question didn't look particularly epiphanic, which is understandable since it would normally be employed by mice for sniffing out food or navigating a maze. Neurologists theorize, however, that this humble-looking material is the common link between the Spartak kids, the Dominican baseball players and all the other blooms on the talent map — a link all the more interesting for the fact that few outside this branch of neurology currently know much about myelin. In fact, as Fields pointed out, if indirectly, the talent map wasn't technically the most accurate name for my hypothetical landscape. It should be called the myelin map.

"I would predict that South Korean women golfers have more myelin, on average, than players from other countries," Fields said. "They've got more in the right parts of the brain and for the right muscle groups, and that's what allows them to optimize their circuitry. The same would be true for any group like that."

"Tiger Woods?" I asked.

"Definitely Tiger Woods," he said. "That guy's got a lot of myelin."

Fields, 53, is a sinewy man with a broad smile and a jaunty gait. A former biological oceanographer who studied shark nervous systems, he now runs a six-person, seven-room lab outfitted with hissing canisters, buzzing electrical boxes and tight bundles of wires and hoses. The place has the feel of a tidy, efficient ship. In addition, Fields has the sea captain's habit of making dramatic moments sound matter-of-fact. The more exciting something is, the more mundane he makes it sound. As he was telling me about the six-day climb of Yosemite's 3,000-foot El Capitan he made two summers back, I asked what it felt like to sleep while hanging from a rope thousands of feet above the ground. "It's actually not that different," he said, his expression so unchanging that he might have been discussing a trip to the grocery store. "You adapt."

Fields reached into the incubator, extracted one of the pink petri dishes and slid it beneath a microscope. "Have a peek," he said quietly.

I leaned in and saw a tangled bunch of spaghetti-like threads, which Fields informed me were nerve fibers. The myelin was harder to see, a faintly undulating fringe on the edge of the neurons. I blinked, refocused, struggled to imagine how this stuff might help my golf game.

Fields proceeded to explain that myelin is a sausage-shaped layer of dense fat that wraps around the nerve fibers — and that its seeming dullness is, in fact, exactly the point. Myelin works the same way that rubber insulation works on a wire, keeping the signal strong by preventing electrical impulses from leaking out. This myelin sheath is, basically, electrical tape, which is one reason that myelin, along with its associated cells, was classified as glia (Greek for "glue"). Its very inertness is why the first brain

researchers named their new science after the neuron instead of its insulation. They were correct to do so: neurons can indeed explain almost every class of mental phenomenon—memory, emotion, muscle control, sensory perception and so on. But there's one question neurons can't explain: why does it take so long to learn complex skills?

"Everything neurons do, they do pretty quickly; it happens with the flick of a switch," Fields said. "But flicking switches is not how we learn a lot of things. Getting good at piano or chess or baseball takes a lot of time, and that's what myelin is good at."

To the surprise of many neurologists, it turns out this electrical tape is quietly interacting with the neurons. Through a mechanism that Fields and his research team described in a 2006 paper in the journal *Neuron*, the little sausages of myelin get thicker when the nerve is repeatedly stimulated. The thicker the myelin gets, the better it insulates and the faster and more accurately the signals travel. As Fields puts it, "The signals have to travel at the right speed, arrive at the right time, and myelination is the brain's way of controlling that speed." 2

It adds up to a two-part dynamic that is elegant enough to please Darwin himself: myelin controls the impulse speed, and impulse speed is crucial. The better we can control it, the better we can control the timing of our thoughts and movements, whether we're running, reading, singing or, perhaps more to the point, hitting a wicked topspin backhand.

Back at Spartak, the Little Group lined up outside the service box, rackets at the ready. Preobrazhenskaya stood at the net, a shopping cart of balls at her hip. She waited for silence, then started: forehand, backhand, back to the end of the line. One by one, the kids took their swings — to my eye, pretty nice-looking swings. But not to hers. Preobrazhenskaya frequently stopped them, had them do it over. More follow-through. More turn. Watch. Feel.

Pravil'no, she said. Correct.

Molodets. Good job.

If Preobrazhenskaya's approach were boiled down to one word (and it frequently was), that word would be *tekhnika* — technique. This is enforced by iron decree: none of her students are permitted to play in a tournament for the first three years of study. It's a notion that I don't imagine would fly with American parents, but none of the Russian parents questioned it for a second. "Technique is everything," Preobrazhenskaya told me later, smacking a table with Khrushchev-like emphasis, causing me to jump and reconsider my twinkly-grandma impression of her. "If you begin playing without technique, it is big mistake. Big, big mistake!"

I thought of something Dr. Fields had said: "You have to understand that every skill exists as a circuit, and that circuit has to be formed and optimized." To put it in Spartak terms, myelin is a slave to *tekhnika* — and so, in turn, was the Little Group. Preobrazhenskaya didn't instruct them on tactics or positioning or offer any psychological tips; rather, every gesture and word was funneled to teaching the elemental task of hitting the ball clean and hard. Which they did, one by one. A few of the kids had located that magical-seeming burst of leverage that makes the ball explode off the strings with a distinctive thwack.

"What do good athletes do when they train?" George Bartzokis, a professor of neurology at U.C.L.A., had told me. "They send precise impulses along wires that give the signal to myelinate that wire. They end up, after all the training, with a super-duper wire — lots of bandwidth, high-speed T-1 line. That's what makes them different from the rest of us." 3

As the Little Group continued its lesson, I found myself picturing myelin. I'd seen a highly magnified image on one of Fields's computer screens, and it looked like a deep-sea photograph: bright colors against a field of black. The oligodendrocytes — oligos, in lab lingo, are the cells that form the myelin — resembled glowing green squids, their tentacles reaching toward a set of slender nerve fibers. Once they seize hold, each tentacle begins to curl and extend, as the oligo squeezes the cytoplasm out of itself until only a cellophane-like sheet of membrane remains. That membrane proceeds to wrap over the nerve fiber with machinelike precision, spiraling down to create the distinctive sausage shape, tightening itself over the fiber like a threaded nut.

"It's one of the most intricate and exquisite cell-cell interactions there is," Fields said. "And it's slow. Each one of these wraps can go around a nerve fiber 40 or 50 times, and that can take days or weeks. Imagine doing that to an entire neuron, then an entire circuit with thousands of nerves."

So each time Alexandra or Denis or Gunda swings the racket properly — or, for that matter, each time we practice a chip shot or a guitar chord or a chess opening — those tiny green tentacles sense it and reach toward the thousands of related nerve fibers. They grasp, they squish, they make another wrap, thickening the sheath. They build a little more insulation along the wire, which adds a bit more bandwidth and precision to the circuit, which translates into an infinitesimal bit more skill and speed. Myelin is both practice and mastery, cause and effect. As Bartzokis had said: "Myelin is our Achilles strength, and it's our Achilles' heel. It's what makes us human." 4

All this myelin talk, combined with jet lag, left me feeling slightly changed. I wandered Moscow as if I were seeing the world through myelin-colored glasses. Emerald-green squids and snowy white sausages were everywhere I looked. A TV highlight of a Ronaldinho goal? Pure myelin! That violinist playing Mozart in the subway? What incredible oligodendrocytes that guy must have! A poster for the 2008 Olympics? An international myelin cultivation contest! My repeated ability to get lost within a few blocks of my hotel? Myelin again! (Rather, my lack of it.)

It also left me thinking about the clusters on the talent map. Specifically, wondering whether these places quietly possess myelin-accelerating factors: i.e., forces and conditions that promote what Fields would call "circuit optimization." Might those factors help explain the success of these superior athletes?

The rise of the South Korean golfers, who won almost one-third of the events last year on the Ladies Professional Golf Association Tour, has usually been explained by citing two factors: the country's formidably driven parents, and the rock-star status of Se Ri Pak, who has won 23 tournaments and is one of the nation's biggest sports celebrities. Yet the logic of this formula has always been confounded by a puzzling fact: South Korea happens to be a nation where it is singularly difficult for a young person to play golf. There are only 200 golf courses in the entire country, compared with 17,000 in the United States.

Viewed through the prism of myelin, however, the situation makes more sense. The lack of public courses sends golf-hungry parents and kids to South Korea's abundant driving ranges, which are Elysian fields of myelination compared to the relative randomness of course play. Were South Korea to increase access to courses, it could be argued, the country might wind up producing fewer top golfers.

Then there's the Dominican Republic, which has historically produced more Major League Baseball players than any other country outside the United States. Conventional wisdom holds that this remarkable record arises from the fruitful collision of a baseball-mad culture and grinding poverty. The equation is undeniably true, but it's also true of several nearby countries that don't achieve a fraction of the Dominican Republic's success.

There is one way, however, in which the Dominican Republic is historically unique. It's the first place where Major League Baseball teams built training academies — two dozen of them, starting in the mid-1970s. While academies provide players with obvious advantages like good nutrition and housing, not to mention regular exposure to scouts, they also provide a daily structure of drills and practices that, like the South Korean driving ranges, would presumably be a ripe environment for building myelin. 5

The most impressive myelin collection I encountered during my Moscow trip belonged to a woman encased in a sheepskin coat, fur-trimmed boots and a fuzzy white hat. Elena Dementieva, 25, represented the acme of the Spartak product. She stood 5-foot-11, weighed 141 pounds and emanated a vibration of such unearthly physical perfection that crowds parted as she moved down the sidewalk. Seeing Dementieva walk into the Russian Army sports club, where she trains between tournaments, I flashed to an image of the Spartak kids and felt a brief parental pang of disbelief. Such a transformation seemed impossible. 6

Sitting down on a set of courtside bleachers (level gaze, warm laugh, no hint of divahood), Dementieva told her story. Surprisingly, she had been rejected by several other clubs as too slow before landing at Spartak. She spoke fondly, if a little vaguely, of her days at the club: dodging stray dogs, washing dirty tennis balls in the sink, doing homework on the long subway ride. Her first instructor was the renowned Rausa Islanova (the mother of Dinara Safina and of the men's 2000 United States Open winner, Marat Safin), who was known for her strictness and her elimination system in which students competed for a constantly shrinking number of slots. Dementieva's group started with 25 students; within a year it was down to 7. Of those 7 kids, 4 became world-class players (Myskina, Kournikova and Safin were the other 3).

"Spartak was good for me, I think," Dementieva said, squinting as if she were peering into her hazy

past. "I always had a feeling that I was going forward, getting better technique."

When Dementieva took the court to practice, she began with a set of those Jack LaLanne-style warm-ups — sidesteps, jumping jacks, high steps. She looked as if she were still a member of the Little Group, so much so that, watching from the bleachers, I was momentarily unsure whether it was her or some beginner. Dementieva did *imitatsiya*; she practiced each stroke in slow motion. Then, when her male sparring partner showed up, she proceeded to hit the ball so hard, accurately and consistently that it seemed she was playing a sport I'd never seen before. Again and again, her body rose to the ball in a twist of ballistic force, the power betrayed only by the snakelike rise of her thick blond braid. The ball hissed.

Trying to wrap my head around the metamorphic process through which a too-slow kid could become . . . her, well, it left me utterly at a loss, able only to fumble for such useful scientific terms as "magic" and "miracle."

Fortunately, there are more rational people to consult, and perhaps the most rational is K. Anders Ericsson, who has devoted much of his life to studying phenomena like Dementieva and Spartak. Ericsson, a native of Sweden and a professor of psychology at Florida State University, is co-editor of "The Cambridge Handbook of Expertise and Expert Performance," published in 2006. If talented people can be thought of as a singular species, then Ericsson is its John J. Audubon, and the handbook is his painstakingly annotated field guide.

The handbook runs to 901 pages, so, in the interest of time, allow me to sum up. Every talent, according to Ericsson, is the result of a single process: deliberate practice, which he defines as "individuals engaging in a practice activity (typically designed by teachers) with full concentration on improving some aspect of their performance." In a moment of towering simplification, "The Handbook" distills its lesson to a formula known as the Power Law of Learning:  $T = a P^{-b}$ . (Don't ask.) A slightly more useful translation: Deliberate practice means working on technique, seeking constant critical feedback and focusing ruthlessly on improving weaknesses.

"It feels like you're constantly stretching yourself into an uncomfortable area beyond what you can quite do," Ericsson told me. It's hard to sustain deliberate practice for long periods of time, which may help explain why players like Jimmy Connors succeeded with seemingly paltry amounts of practice while their competitors were hitting thousands of balls each day. As the tennis commentator Mary Carillo told me, "He barely practiced an hour a day, but it was the most intense hour of your life."

Ericsson also discusses the Ten-Year Rule, an intriguing finding dating to 1899, which shows that even the most talented individual requires a decade of committed practice before reaching world-class level. (Even a prodigy like the chess player Bobby Fischer put in nine hard years before achieving his grandmaster status at age 16.) While this rule is often used to backdate the ideal start of training (in tennis, girls peak physically at around 17, so they ought to start by 7; boys peak later, so 9 is O.K.), the Ten-Year Rule has more universal implications. Namely, it implies that all skills are built using the same fundamental mechanism, and that the mechanism makes physiological demands from which no one is exempt.

This is not to suggest that the only difference between an average Joe and Michael Jordan is a few thousand hours of deliberate practice. Almost all of the scientists I spoke with agreed that inheritance is a huge factor in potential, if perhaps not in quite the way we've commonly assumed. (Perhaps, as George Bartzokis suggests, Jordan's greatest natural gift was his powerful oligodendrocytes.)

All in all, Ericsson's theory sounds logical and appealing, but part of me rises up in rebellion. What about geniuses? What about young Mozart's famous ability to transcribe entire scores on a single hearing? What about Shakespeare or Leonardo or those 14-year-old Ph.D. candidates? What about savants, who walk up to the piano or a Rubik's cube and are magically brilliant?

$T = a P^{-b}$  would be the reply. In his 1999 book, "Genius Explained," Michael Howe of the University of Exeter speculates that Mozart studied some 3,500 hours of music with his instructor father by his sixth birthday, a number that places his musical memory into the realm of impressive but obtainable party tricks. Savants, it is pointed out, excel within narrow domains that feature clear, logical rules (classical piano, math, occasionally art — as opposed to, say, jazz clarinet). Furthermore, savants typically possess prior exposure to those domains, such as listening to music around the home. Savants' true expertise, the research suggests, is in their ability to practice obsessively, even when it doesn't look as if they're practicing. As Ericsson succinctly put it, "There's no cell type that geniuses have that the rest of us don't."

So let's return to the initial question: how does Spartak do it? If the new science is right and myelination is to talent as photosynthesis is to plant growth, then Spartak makes it abundantly clear that photosynthesis alone is never enough; you also need soil, water, air, sunlight, luck. The question becomes, which variables are helping Spartak's myelin grow to such riotous abundance? Four factors stand above the rest:

1. Driven Parents. The hunger and ambition of Russian parents is uniquely strong, particularly when one considers how hard life is in Russia right now and also that the patron saint of Russian tennis parents is the ex-Siberian oil-field worker Yuri Sharapov, who came to America with less than \$1,000 and his 7-year-old daughter, Maria, who now earns an estimated \$30 million a year in endorsements. On the other hand, while they are intense, Russian parents aren't all that different a group from the parents in Serbia, the Czech Republic or Mission Viejo, Calif.
2. Early Starts. The kids here start young and specialize early. They are tennis players, and not much else competes for their attention (only a handful owned video games, according to my informal poll), and they also benefit from a Russian culture that's built to select athletes and shield them from academic pressures. Incidentally, there were indeed elite athletic genes floating around at Spartak: Alexandra's parents were famous figure skaters, and another kid was Myskina's cousin. So good genes probably play a role, or (just as likely, to my mind) there's a beneficial effect to growing up in an environment of working athletes.
3. Powerful, Consistent Coaches. Most tennis coaches I saw were treated with a respect reserved for university professors. The tennis clubs I visited were patrolled by a squad of Brezhnev lookalikes who offered advice that seemed hewed from stone. Their institutional specialty is biomechanics, but the point is perhaps not so much in the details of that coaching, but rather in the passion, rigor and uniformity with which that coaching is delivered. This, incidentally, is the opposite of the entrepreneurial system in which many American tennis coaches operate, as they often compete with one another, relying on their ability to sell their services to sometimes anxious parents. American coaches have to be unique to survive; Russian coaches are mostly the same.
4. Cultural Toughness. As poets have pointed out, the intrinsic hardiness of the Russian woman is legendary. Historically, this might have something to do with the hardships of life under Communism and the loss of 11 million soldiers in World War II. Whatever the cause, the immediate effect is a tangible mental toughness and a work ethic second to none. After all, at Spartak, they don't speak of "playing" tennis. The verb they like to use is borot'sya — to struggle.

If I gave in to the uncontrollable Ericssonian urge to put Spartak's success into a formula, it would read something like:

Intense Parents + Young Kids + Rigorous Technique + Toughness = Talent

Alongside it, we could write another equation:

Deliberate Practice + Time = Myelin = Talent

But in the end, as I look around the court, it can't come down to a formula because formulas are rational, and whatever Spartak is, it isn't entirely rational. It's a bunch of kids in a dumpy club who are burning to be here, for whom every swing is meaningful, who wake up in the morning and say, "Today is my day with Larisa Dmitrievna!" It's deeply and purposefully irrational, because it's built on a love of sport and country that can't be explained but holds everything together anyway. Spartak is not science; what happens here is not analogous to what happens in a factory or a laboratory. It's closer to what happens in a garden, a forgotten, rundown garden that somehow produces marvelous tomatoes, summer after summer. 7

Thwock . . . thwock . . . thwock . . . thwock.

The Little Group was smacking it now, the balls zipping over the net and ricocheting off the far wall. Preobrazhenskaya, the gardener, watched with a smile, occasionally correcting a backswing or a grip, nudging the kids on with a murmur of praise and instruction: "Clever boy." "Good girl." "No." "Correct." "Not there." "That's it."

On my last day at Spartak, I met one more player. Her name was Kseniya; she was 5, and she'd come for a tryout. Her parents, an upscale pair, ducked through the low door and asked Larisa Dmitrievna if she might have a moment. Kseniya had black pigtails held in place with pink ribbons. She wore new silver tennis shoes. She walked solemnly, one step behind her parents, carrying a tiny pink racket.

Something in the precision of her walk, in her air of self-possession, reminded me of my daughter Zoe.

Preobrazhenskaya put her arm on Kseniya's shoulder and walked her to the corner of the court, out of the parents' earshot. The girl looked up into the coach's face. "She has good eyes," Preobrazhenskaya said later.

Preobrazhenskaya rotated Kseniya's arms in a wide circle, feeling for looseness in her muscles, which she regarded as a good sign. Preobrazhenskaya then showed Kseniya a new tennis ball, and told her what was about to happen. Kseniya listened closely, and nodded. Then the coach tossed the ball lightly, and Kseniya, her small body coming alive at once, ran to catch it.

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## FOOTNOTES

1 In September, as part of an ongoing effort to revive American tennis, the United States Tennis Association plans to centralize its player development program at the Evert Tennis Academy in Boca Raton, Fla., a new complex that will feature 23 courts (14 lighted), dormitories, a state-of-the-art video lounge and a staff of 30, including a mental-conditioning coach. Tuition with room and board will cost as much as \$42,000 a year. By comparison, the Russian Tennis Federation's total youth-development budget is estimated to be between \$300,000 and \$400,000.

2 Timing is vital because neurons are binary: either they fire or they don't — no gray areas. Their firing depends solely on whether the incoming impulse is strong enough to exceed the neuron's threshold of activation. To explain the implications of this effect, Fields had me imagine a skill circuit in which two neurons need to combine their impulses to make a third, high-threshold neuron fire — for, say, a golf swing. In order to combine properly, those two incoming impulses must arrive at nearly exactly the same time — sort of like two people running at a heavy door to push it open. The time window turns out to be about four milliseconds, or roughly the time it takes a bee to flap its wings once. If the first two signals arrive more than four milliseconds apart, the door stays shut, the crucial third neuron doesn't fire and the golf ball soars into the rough (or, as I was reflexively picturing, Zoe swings and misses the purple ball). "Your brain has so many connections and possibilities that your genes can't code the neurons to time things so precisely," Fields said. "But you can build myelin to do it."

3 These studies shine a new light on the neuro-anatomist Marian C. Diamond's 1985 finding that the left, inferior parietal lobe of Albert Einstein's brain, though it had a typical number of neurons, had significantly more glial cells than her other samples, a study that neurologists at the time considered so meaningless as to be nearly comical but that now seems to make sense, bandwidth-wise.

4 The list of myelin-related pathologies is long and, Bartzokis believes, includes multiple sclerosis and Alzheimer's as well as a wider range of conditions, like schizophrenia, dyslexia, attention-deficit/hyperactivity disorder and autism, all of which can be understood as disorders of impulse timing.

5 Venezuela is a more recent example of this phenomenon. In 1989, the Houston Astros opened the first of what are now nine major-league academies there, and a few years later, the number of Venezuelans in the big leagues started to rise. Since 1995, 125 Venezuelans have broken into Major League Baseball, 51 more than had appeared in all the years up to that point.

6 In children, myelin arrives in a series of waves, some of them determined by biological code, some of them dependent on activity. These waves last into young adulthood. Until this time, the brain is extraordinarily receptive to learning new skills. Though adults retain the ability to myelinate throughout life (thankfully, 5 percent of our oligos remain immature, ready to answer the call), anyone who has tried to learn a language or musical instrument late in life can testify that it costs a lot more time and sweat to build the requisite circuitry. The effortlessness is the first thing to go.

7 Replicating the Spartak system in the United States (or, for that matter, installing Dominican-style baseball academies or forcing young golfers to practice only at driving ranges) would likely not create a sudden wellspring of stars. The reasons that the United States is losing ground on the talent map have less to do with training mechanisms and more to do with bigger factors: a highly distractive youth culture, a focus on the glamour of winning rather than on the brickwork of building technique and a sporting environment that is gentler than those found in many of the world's harder corners.

"You can't keep breast-feeding them all the time," Robert Lansdorp, a tennis coach in Los Angeles, told me. "You've got to make them an independent thinker." Lansdorp, who is in his 60s, has coached

Sharapova, along with the former No. 1-ranked players Pete Sampras, Tracy Austin and Lindsay Davenport, all three of whom grew up in the same area and played at the same run-of-the-mill tennis clubs near Los Angeles. "You don't need a fancy academy," he said. "You need fundamentals and discipline, and in this country nobody gives a damn about fundamentals and discipline." Lansdorp also mentioned that he'd visited Spartak last year to teach a clinic. "It was a pretty different place," he said. "But that Larisa, she sure knows her stuff."

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Notes:

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