

The New York Times® Reprints

This copy is for your personal, noncommercial use only. You can order presentation-ready copies for distribution to your colleagues, clients or customers [here](#) or use the "Reprints" tool that appears next to any article. Visit www.nytreprints.com for samples and additional information. [Order a reprint of this article now.](#)

January 25, 2012

Applied Neuroscience, the Six-String Method

By **[BRUCE HEADLAM](#)**

At 13, an age when most boys want to learn the guitar, Gary Marcus, decided he wanted to be a scientist. Twenty-five years later he had become one of the country's best known cognitive psychologists, with major papers and three general-interest books on the workings of the human mind and a position running New York University's Center for Language and Music.

And he wanted to play the guitar.

For any adult learning an instrument or a new language is terrifying. For a cognitive scientist, it can also be downright depressing. Humans have an early childhood window to acquire such skills easily, according to a long-held tenet in his profession, and it's a window that closes quickly. Then there is the issue of innate ability. While no single gene can explain Beethoven, Yo-Yo Ma or "Waterloo Sunset," Dr. Marcus does believe in natural talent, he said, or at least in the certainty he doesn't have any.

Despite those misgivings he allowed himself one year of dedicated practice, armed with instruction books, a \$75 Yamaha acoustic bought on eBay and one thing few adult music students have at their disposal: a year's sabbatical.

Three years later he has chronicled his journey in a new book, "[Guitar Zero: The New Musician and the Science of Learning](#)" (Penguin). Like Daniel J. Levitin's "[World in Six Songs: How the Musical Brain Created Human Nature](#)" and Oliver Sacks's "[Musicophilia](#)," "Guitar Zero" investigates the intersection between neuroscience and music. But the thread here is Dr. Marcus's own often frustrating attempts to learn guitar. It's the sort of book where Steven Pinker (Dr. Marcus's mentor and collaborator) mixes with K. Anders Ericsson (the psychologist most associated with the "10,000 hours" theory of expertise) and Tom Morello (the lead guitarist from Rage Against the Machine).

Wearing a black jacket and electric-blue dress shirt last week in his N.Y.U. office, Dr. Marcus, now 41, may not be Rage Against the Machine material, but he wouldn't look out of place in an

'80s New Wave group or maybe a new outfit called Public Intellectuals Limited.

“You could ask from an evolutionary perspective why anyone plays music in the first place,” he said, although in fact you have to ask very few questions in conversation with Dr. Marcus because he poses so many himself — then answers them.

“I don't think music is innately wired in the brain. It's a difficult skill. So why do we do it?”

His brain didn't seem wired for it. Growing up in Baltimore, he loved listening to his parents' Beatles and Peter, Paul and Mary records, but he was uncoordinated, given to bouts of motion sickness and unable even to use a playground swing. “I think it's something to do with my cerebellum,” he said. He flunked an aptitude test for band and was discouraged from playing the recorder which, in public school, pretty much leaves the tambourine.

Five years ago he asked a fellow scientist, Dr. Levitin, to show him a few chords. “His timing was off,” Dr. Levitin said. “I told him to practice with a metronome.” But Dr. Marcus couldn't keep the beat and feared there might be a neurological explanation: a form of musical arrhythmia. Now even the tambourine seemed out of the question.

“I always thought music was one of the things I was absolutely worst at but was compelled to try,” he said, drawing a small graph on a notebook in front of him, the “x” representing time and the “y” musical ability. “Here is Hendrix,” he said, graphing a line at about 60 degrees, then tracing the x axis: that's him. “I thought I was just a flatline.”

But as a scientist he was keenly interested in the compensatory mechanisms: how the brain can essentially rewire itself to make up for deficits caused by a stroke, trauma or even a nonexistent sense of rhythm. Maybe with training his prefrontal cortex could accomplish what his cerebellum couldn't.

What finally pushed him wasn't seeing Springsteen in concert or listening to the “Goldberg” Variations. It was a video game, Guitar Hero, that rewards players who can press the correct buttons in time with recorded music. He was terrible at first, but through sheer repetition he improved just enough to think that maybe rhythm could be learned after all. But real guitars, he was frustrated to learn, weren't designed by computer engineers.

Compared to his Guitar Hero controller his Yamaha felt heavy and awkward. The musical scale isn't perfectly linear. (Quick: what's another name for C flat?) And the guitar has the same notes at different frets along different strings. “That's something the brain doesn't want to deal with,” he said. “There's no one-to-one relationship on where the notes are. You have all

these memory traces that interfere with one another.”

He feared the window had closed for good, but with everyday practice, single notes became scales, and his smallish hands became strong enough to form chords. “It was gradual and piecemeal,” his wife, Athena Vouloumanos, a neuroscientist and assistant professor at N.Y.U., remembered. “He had to think about the beat and figure it out in an analytical way.”

Three years later his practice is now aimed almost purely at improvisation. At the book party/mini-concert for “Guitar Zero,” held in front of students and friends at an N.Y.U. lecture hall last week, he was joined on stage by Terre Roche, a longtime music teacher and part of the singing group [the Roches](#), to improvise in a scale he had learned that morning.

Over a simple chord progression, he picked out notes on the guitar fluently and with a clear sense of direction, always landing on a chord note at the end of a phrase. It wasn’t a perfect flight, but he didn’t crash into any walls either.

Afterward Ms. Roche, who specializes in teaching adults, said, “I see a lot of fear in adults, fear of looking silly, fear of feeling foolish: ‘Why didn’t I start earlier?’ ” Dr. Marcus was forthright about his deficiencies. “We did a lot working really slowly, which fortunately he liked to do,” she said.

But he had no interest in learning particular songs. Nor has he tried to acquire the tricks that most fledgling players rely on by reading transcriptions of Chuck Berry or Eric Clapton licks, and he may be the only amateur guitarist alive who doesn’t spontaneously play “[Blackbird](#)” over and over.

“I have a lot of need for cognition,” he said. “I want to know how the guitar works. Some people are ‘show me this riff in “Hey Joe.” I’m not that kind of player.”

Those two approaches — learning the scales or learning “Hey Joe” — illustrate different modes of mental processing that are at the heart of “Guitar Zero.” On the one hand is abstract thinking, basically a tool kit of rules that can be applied in new situations. Atonal music, which relies on a strict sequence of notes, might be the best example.

The other is data mining, that is, dredging up material from a vast store of knowledge. Paul McCartney can’t read notation, but he has a vast store of music to draw on and could, for example, compose “Blackbird” based on a Bach lute piece he learned as a child.

Dr. Marcus is particularly interested in how the human mind toggles between the two

approaches. As a scientist he gives equal weight to both ways of thinking, but as a player he clearly prefers rules to riffs.

Like most musicians he wants to move beyond both and play from emotion or, as he said, “from the brain stem.” “I’m still analytical at most moments,” he said. “I’m not sure if that’s a limitation of me as a musician or as a human being.”

In the meantime there are other compensations. He has shifted his research from language to music, developed several iPad apps (including one for improvisation) and he now teaches a course at N.Y.U. called “Guitar Hero (and Heroines): Music, Video Games and the Nature of Cognition.” He even admits to enjoying heavy metal for its nerdy embrace of complicated scales. “I love ‘Stairway to Heaven’ now,” he said.

And his rhythm has improved to the point that he was actually complimented on his dancing at a wedding a few months ago.

“I’m not great,” he said. “But for an academic, I think they were reasonably impressed.”