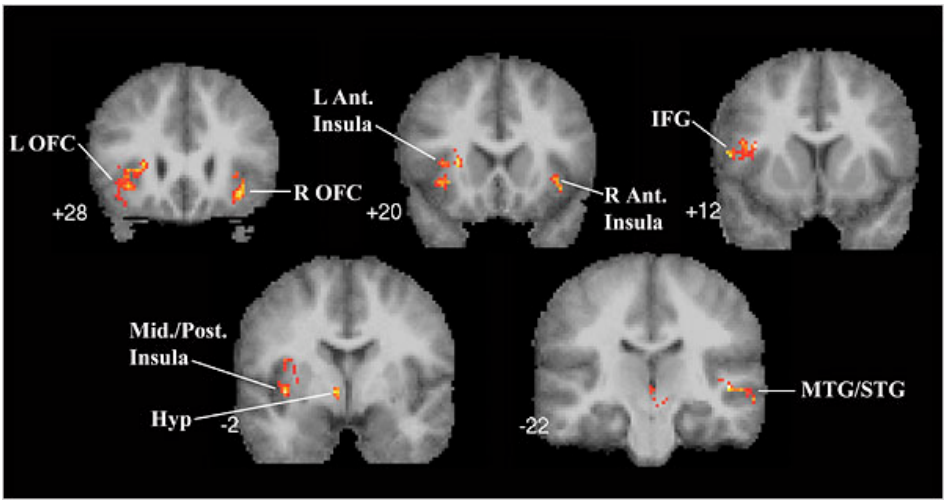
Music of the Hemispheres



Images courtesy of Vinod Menon (Stanford University)

Images from an experiment to locate the neural regions of the brain involved in listening to music. Daniel Levitin and another scientist scanned the brains of 13 people as they listened to scrambled and unscrambled versions of a tune.

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Stuart McCall/Getty Images, for The New York Times

Daniel Levitin is the rare music scientist to have worked in the music business. "Pop musicians compose with timbre," he said. "Pitch and

"Listen to this," Daniel Levitin said. "What is it?" He hit a button on his computer keyboard and out came a half-second clip of music. It was just two notes blasted on a raspy electric guitar, but I could immediately identify it: the opening lick to the Rolling Stones' "Brown Sugar."

Then he played another, even shorter snippet: a single chord struck once on piano. Again I could instantly figure out what it was: the first note in Elton John's live version of "Benny and the Jets."

Dr. Levitin beamed. "You hear only one note, and you already know who it is," he said. "So what I want to know is: How we do this? Why are we so good at recognizing music?"

This is not merely some whoa-dude epiphany that a music

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harmony are becoming less important."

fan might have while listening to a radio contest. Dr. Levitin has devoted his career to exploring this question. He is a cognitive psychologist who runs the Laboratory for Music Perception, Cognition and Expertise at McGill University in Montreal, perhaps the world's leading lab in probing why music has such an intense effect on us.

"By the age of 5 we are all musical experts, so this stuff is clearly wired really deeply into us," said Dr. Levitin, an eerily youthful-looking 49, surrounded by the pianos, guitars and enormous 16-track mixers that make his lab look more like a recording studio.

This summer he published "This Is Your Brain on Music" (Dutton), a layperson's guide to the emerging neuroscience of music. Dr. Levitin is an unusually deft interpreter, full of striking scientific trivia. For example we learn that babies begin life with synesthesia, the trippy confusion that makes people experience sounds as smells or tastes as colors. Or that the cerebellum, a part of the brain that helps govern movement, is also wired to the ears and produces some of our emotional responses to music. His experiments have even suggested that watching a musician perform affects brain chemistry differently from listening to a recording.

Dr. Levitin is singular among music scientists for actually having come out of the music industry. Before getting his Ph.D. he spent 15 years as a record producer, working with artists ranging from the Blue Öyster Cult to Chris Isaak. While still in graduate school he helped Stevie Wonder assemble a best-of collection; in 1992 Dr. Levitin's sensitive ears detected that MCA Records had accidentally used third-generation backup tapes to produce seven Steely Dan CDs, and he embarrassed the label by disclosing it in Billboard magazine. He has earned nine gold and platinum albums, which he tucks in corners of his lab, office and basement at home. "They look a little scary when you put them all in one place, so I spread them around," he said.

Martin Grant, the dean of science at McGill, compares Dr. Levitin's split professional personality to that of Brian Greene, the pioneering string-theory scientist who also writes mass-market books. "Some people are good popularizers, and some are good scientists, but not usually both at once," Dr. Grant said. "Dan's actually cutting edge in his field."

Scientifically, Dr. Levitin's colleagues credit him for focusing attention on how music affects our emotions, turf that wasn't often covered by previous generations of psychoacousticians, who studied narrower questions about how the brain perceives musical sounds. "The questions he asks are very very musical, very concerned with the fact that music is an art that we interact with, not just a bunch of noises," said Rita Aiello, an adjunct professor in the department of psychology at New York University.

Ultimately, scientists say, his work offers a new way to unlock the mysteries of the brain: how memory works, how people with autism think, why our ancestors first picked up instruments and began to play, tens of thousands of years ago.

DR. LEVITIN originally became interested in producing in 1981, when his band — a punk outfit called the Mortals — went into the recording studio. None of the other members were interested in the process, so he made all the decisions behind the board. "I actually became a producer because I saw the producers getting all the babes," he said. "They were stealing them from the guitarists." He dropped out of college to work with alternative bands.

Producers, he noted, were able to notice impossibly fine gradations of quality in music. Many could identify by ear the type of amplifiers and recording tape used on an album.

"So I started wondering: How was the brain able to do this?" Dr. Levitin said. "What's

going on there, and why are some people better than others? And why is music such an emotional experience?" He began sitting in on neuroscience classes at Stanford University.

"Even back then, Dan was never satisfied with the simple answer," said Howie Klein, a former president of Reprise and Sire Records. "He was always poking and prodding."

By the '90s Dr. Levitin was disenchanted with the music industry. "When they're dropping Van Morrison and Elvis Costello because they don't sell enough records," he said, "I knew it was time to move on." Academic friends persuaded him to pursue a science degree. They bet that he would have good intuitions on how to design music experiments.

They were right. Traditionally music psychologists relied on "simple melodies they'd written themselves," Dr. Levitin said. What could that tell anyone about the true impact of powerful music?

For his first experiment he came up with an elegant concept: He stopped people on the street and asked them to sing, entirely from memory, one of their favorite hit songs. The results were astonishingly accurate. Most people could hit the tempo of the original song within a four-percent margin of error, and two-thirds sang within a semitone of the original pitch, a level of accuracy that wouldn't embarrass a pro.

"When you played the recording of them singing alongside the actual recording of the original song, it sounded like they were singing along," Dr. Levitin said.

It was a remarkable feat. Most memories degrade and distort with time; why would pop music memories be so sharply encoded? Perhaps because music triggers the reward centers in our brains. In a study published last year Dr. Levitin and group of neuroscientists mapped out precisely how.

Observing 13 subjects who listened to classical music while in an M.R.I. machine, the scientists found a cascade of brain-chemical activity. First the music triggered the forebrain, as it analyzed the structure and meaning of the tune. Then the nucleus accumbus and ventral tegmental area activated to release dopamine, a chemical that triggers the brain's sense of reward.

The cerebellum, an area normally associated with physical movement, reacted too, responding to what Dr. Levitin suspected was the brain's predictions of where the song was going to go. As the brain internalizes the tempo, rhythm and emotional peaks of a song, the cerebellum begins reacting every time the song produces tension (that is, subtle deviations from its normal melody or tempo).

"When we saw all this activity going on precisely in sync, in this order, we knew we had the smoking gun," he said. "We've always known that music is good for improving your mood. But this showed precisely how it happens."

The subtlest reason that pop music is so flavorful to our brains is that it relies so strongly on timbre. Timbre is a peculiar blend of tones in any sound; it is why a tuba sounds so different from a flute even when they are playing the same melody in the same key. Popular performers or groups, Dr. Levitin argued, are pleasing not because of any particular virtuosity, but because they create an overall timbre that remains consistent from song to song. That quality explains why, for example, I could identify even a single note of Elton John's "Benny and the Jets."

"Nobody else's piano sounds quite like that," he said, referring to Mr. John. "Pop

musicians compose with timbre. Pitch and harmony are becoming less important."

Dr. Levitin dragged me over to a lab computer to show me what he was talking about. "Listen to this," he said, and played an MP3. It was pretty awful: a poorly recorded, nasal-sounding British band performing, for some reason, a Spanish-themed ballad.

Dr. Levitin grinned. "That," he said, "is the original demo tape of the Beatles. It was rejected by every record company. And you can see why. To you and me it sounds terrible. But George Martin heard this and thought, 'Oh yeah, I can imagine a multibillion-dollar industry built on this.'

"Now that's musical genius."

THE largest audience that Dr. Levitin has performed in front of was 1,000 people, when he played backup saxophone for Mel Tormé. Years of being onstage piqued Dr. Levitin's interest in another aspect of musical experience: watching bands perform. Does the brain experience a live performance differently from a recorded one?

To find out, he and Bradley Vines, a graduate student, devised an interesting experiment. They took two clarinet performances and played them for three groups of listeners: one that heard audio only; one that saw a video only; and one that had audio and video. As each group listened, participants used a slider to indicate how their level of tension was rising or falling.

One rapid, complex passage caused tension in all groups, but less in the one watching and listening simultaneously. Why? Possibly, Dr. Levitin said, because of the performer's body language: the clarinetist appeared to be relaxed even during that rapid-fire passage, and the audience picked up on his visual cues. The reverse was also true: when the clarinetist played in a subdued way but appeared animated, the people with only video felt more tension than those with only audio.

In another, similar experiment the clarinetist fell silent for a few bars. This time the viewers watching the video maintained a higher level of excitement because they could see that he was gearing up to launch into a new passage. The audio-only listeners had no such visual cues, and they regarded the silence as much less exciting.

This spring Dr. Levitin began an even more involved experiment to determine how much emotion is conveyed by live performers. In April he took participants in a Boston Symphony Orchestra concert — the conductor Keith Lockhart, five of the musicians and 15 audience members — and wired them with sensors to measure their state of arousal, including heart rate, body movements and muscle tension.

At one point during the performance Mr. Lockhart swung his wrist with such force that a sensor attached to his cuff went flying off. Dr. Levitin's team tried to reattach it with duct tape, until the conductor objected — "Did you just put duct tape on an Armani?" he asked — and lighter surgical tape was used instead.

The point of the experiment is to determine whether the conductor creates noticeable changes in the emotional tenor of the performance. Dr. Levitin says he suspects there's a domino effect: the conductor becomes particularly animated, transmits this to the orchestra and then to the audience, in a matter of seconds. Mr. Lockhart is skeptical. "As a conductor," he said, "I'm a causatory force for music, but I'm not a causatory force for emotion." But Dr. Levitin is still crunching the data.

"It might not turn out to be like that," he said, "But wouldn't it be cool if it did?"

Dr. Levitin's work has occasionally undermined some cherished beliefs about music. For

example recent years have seen an explosion of "Baby Mozart" videos and toys, based on the idea — popular since the '80s — that musical and mathematical ability are inherently linked.

But Dr. Levitin argued that this could not be true, based on his study of people with Williams syndrome, a genetic disorder that leaves people with low intelligence. Their peak mental capacities are typically those of young child, with no ability to calculate quantities. Dr. Levitin once asked a woman with Williams to hold up her hand for five seconds; she left it in the air for a minute and a half. "No concept of time at all," he said, "and definitely no math."

Yet people with Williams possess unusually high levels of musical ability. One Williams boy Dr. Levitin met was so poorly coordinated he could not open the case to his clarinet. But once he was holding the instrument, his coordination problems vanished, and he could play fluidly. Music cannot be indispensably correlated with math, Dr. Levitin noted, if Williams people can play music. He is now working on a study that compares autistics — some of whom have excellent mathematical ability, but little musical ability — to people with Williams; in the long run, he said, he thinks it could help shed light on why autistic brains develop so differently.

Not all of Dr. Levitin's idea have been easily accepted. He argues, for example, that music is an evolutionary adaptation: something that men developed as a way to demonstrate reproductive fitness. (Before you laugh, consider the sex lives of today's male rock stars.) Music also helped social groups cohere. "Music has got to be useful for survival, or we would have gotten rid of it years ago," he said.

But Steven Pinker, a cognitive scientist at Harvard known for his defense of evolutionary psychology, has publicly disparaged this idea. Dr. Pinker has called music "auditory cheesecake," something pleasant but not evolutionarily nutritious. If it is a sexual signal for reproduction, then why, Dr. Pinker asked, does "a 60-year-old woman enjoy listening to classical music when she's alone at home?" Dr. Levitin wrote an entire chapter refuting Dr. Pinker's arguments; when I asked Dr. Pinker about Dr. Levitin's book he said he hadn't read it.

Nonetheless Dr. Levitin plugs on, and sometimes still plugs in. He continues to perform music, doing several gigs a year with Diminished Faculties, a ragtag band composed entirely of professors and students at McGill. On a recent December afternoon members assembled in a campus ballroom to do a sound check for their performance that evening at a holiday party. Playing a blue Stratocaster, Dr. Levitin crooned the Chris Isaak song "Wicked Game." "I'm not a great guitarist, and I'm not a great singer," he said.

But he is not bad, either, and still has those producer's ears. When "Wicked Game" ended, the bass player began noodling idly, playing the first few notes of a song that seemed instantly familiar to all the younger students gathered. "That's Nirvana, right?" Dr. Levitin said, cocking his head and squinting. " 'Come As You Are.' I love that song."

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