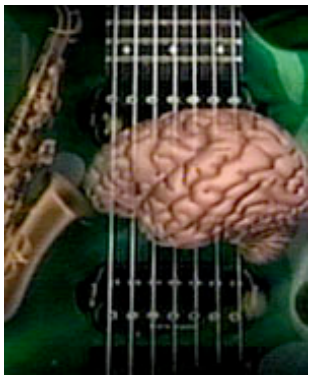
TRANSCRIPT

Originally Aired: February 5, 2007

Report

Music Provides Window into Brain Function

Studying how the brain processes music allows researchers to better understand how the human brain evolved, and how different parts of the brain communicate with each other, according to cognitive neuroscientist and former record producer Daniel Levitin.



RealAudio | Download Streaming Video

JEFFREY BROWN: On a cold winter night at Montreal's Cafe Campus recently, the Kevin Mark Blues Band was thumpin', the crowd was jumpin', the joy and thrill of music was in the air. Onstage, joining in for the classic Joe Turner number "Flip, Flop, Fly," 49-year-old Daniel Levitin wailed away on his saxophone.

Levitin spent more than a decade as an award-winning record producer, working with the likes of Stevie Wonder and Eric Clapton. But he wanted to understand more about music. And today, the sax man is a scientist, a professor of cognitive neuroscience at McGill University, and author of the book, "This Is Your Brain on Music."

By combining the latest technology with traditional experimental psychology, he's become one of the world's leading researchers on how the human brain makes sense of one of humankind's oldest passions.

DANIEL LEVITIN, Cognitive Neuroscientist, McGill University: I think of music as a kind of window into brain function, a way of studying the brain, because music is something that allows us to better understand how the brain evolved and how our species evolved, a way to better understand how the different parts of the brain communicate with each other, how the brain is wired up.

JEFFREY BROWN: Now, for most of us, the pleasure of music is what you might call a no-brainer, something so obvious it's hard to see what science might investigate.

What is it about music that you love?

CONCERTGOER: Ah! Ooh! Ah!

JEFFREY BROWN: Yes? Where does it hit you? Right there?

CONCERTGOER: When you want to dance, it's just, like -- no, it's there.

How the brain processes sound

JEFFREY BROWN: It's there. What about up here, in your brain?

Well, no, say scientists. All music -- indeed, everything we hear, from the human voice to a jet engine's roar -- begins as a pattern of sound waves traveling through the air until it strikes the eardrums.

By themselves, the waves are only scrambled air. There's nothing to indicate whether the waves represent a guitar, a sax, a style, like the blues, or even that it's "music" at all. It's the brain that recognizes the sound of music, separating out the different elements that make up what we call music, pitch for different notes, for example, or timbre, what distinguishes a C on a guitar from one on a piano.

DANIEL LEVITIN: The brain is an analysis system. It's a bunch of special-purpose computers that are trying to extract pitch, rhythm, tempo, meaning of the words, the timbre of instruments.

JEFFREY BROWN: Different parts of the brain are trying to figure out each part of the music?

DANIEL LEVITIN: Yes, and it all comes together later, but it happens so fast.

JEFFREY BROWN: Yes, when you say "later," you mean...

DANIEL LEVITIN: I mean milliseconds. So it happens so fast, Jeff, and it's happening at a subconscious level -- you don't have any conscious control over it -- that it seems all automatic and seamless. And by the time we get an awareness of what it is, it's one full package. We hear the song as a whole.

Why music brings pleasure

JEFFREY BROWN: With magnetic resonance imaging, Levitin and his colleagues map the flow of blood to different parts of the brain, indicating neurons or nerve cells firing as they do their work.

The auditory cortex, for example, first recognizes the nerve impulses coming from the ear. The association cortex compares the music it's hearing with past memories, helping us to recognize a tune.

In a recent experiment, Levitin scanned the brains of people while they listened to music they liked.

DANIEL LEVITIN: What we were after was to see if the known pleasure network, the circuits associated with the pleasure of eating chocolate or winning a reward or having an orgasm, would actually activate in response to listening to pleasurable music. And what we find in this study is that the nucleus accumbens, the hypothalamus, and down here the ventral tegmental region are activated in response to listening to music.

JEFFREY BROWN: All right. So what does all that tell you?

DANIEL LEVITIN: It tells us, for one thing, that we've got some neural corroboration to the self-report that people say they like music. Well, yes, here it is.

JEFFREY BROWN: Levitin and his students use an array of elaborate, high-end audio gear, including a fully equipped recording studio, in their quest to learn how our musical minds function. It's attracted the attention of some high-profile musicians, like Joni Mitchell.

The keyboard on this disklavier can play back a piece of music, such as Beethoven's "Moonlight Sonata," as it was recorded. But with a few key strokes, Levitin can remove certain qualities, such as expressiveness, allowing him to measure precisely how much the human brain can track those changes.

DANIEL LEVITIN: How much variation in the real world maps to an equivalent variation in the mental world? So 50 percent of variability in the acoustics don't equal 50 percent of variability in the brain. The brain isn't set up that way.

Born with a 'music module'?

JEFFREY BROWN: Music, of course, comes in many forms and appears to have been part of every age and every known culture. There's a continuing debate among scientists as to music's exact role in human evolution.

But Levitin believes that the brain itself has evolved to make sense of music and that we're each born wired for music, just as we are for language.

DANIEL LEVITIN: If you're born listening to Chinese opera, your brain is going to become wired to the rules of that musical form. If you're born listening to Pakistani music, Indian music, Indian ragas, your brain will become wired to those. Our brain is plastic, and malleable, and able to wire itself up to whatever language we hear, to learn those rules.

Similarly, I would argue that we all are born with a music module. We're born with the wiring to accommodate any music that we hear, and we learn those rules effortlessly just by listening.

JEFFREY BROWN: Levitin says there's an area of the brain, in the prefrontal cortex, specifically dedicated to comparing what we hear with our expectations of learned patterns of music. That's the reason we can be surprised, pained or delighted when those expectations are tampered with, something great musicians know to exploit.

DANIEL LEVITIN: When you listen to Stevie Wonder drumming on "Superstition," for example, he's playing in time, and you're forming predictions about what's going to happen next. The additional nuance that he brings to it is that he changes the beats ever so slightly, throughout the whole song, "Superstition," never the same.

So he's going a little bit different. He varies the pressure on the high-hat cymbal, so it's a little bit louder, a little bit softer. The beauty of it is that the cerebellum is trying to figure out, "OK, where is the next beat going to come? What's it going to be?" And he's surprising the cerebellum at every turn, so that your brain...

JEFFREY BROWN: We don't talk to too many scientists who are doing Stevie Wonder drum solos for us, I've got to tell you that.

Emotion generated

JEFFREY BROWN: Now, at the club, no one was thinking about their cerebellum. But backstage, after his performance, Levitin said that's one of the key things music lovers just didn't get: all that emotion, what you think you feel in your gut, is generated in your brain.

I'm watching the crowd out there. They're going crazy.

DANIEL LEVITIN: Yes, they're going nuts, yes.

JEFFREY BROWN: Is it their brains that are going crazy?

DANIEL LEVITIN: Well, yes, because, again, you know, if you take the brain out of the head, there ain't going to be nothing to go crazy there. I mean, they're feeling it in their -- they have this sense that they're feeling it in their bodies, and in their souls, and in their hearts, and their spirits, but, really, you know, to a neuroscientist, it all reduces to patterns of firings. And I don't mean to mean to make that sound like, you know, cold and clinical or unromantic or anything, but I think that's what it is.

JEFFREY BROWN: Do you ever fear that, in this work you're doing, because now you know these things, you know how it works, do you ever fear that you will lose the love for performing, the love for music?

DANIEL LEVITIN: Well, it's been the opposite. I feel so much more engaged and invigorated by the study of it, because each new thing reveals to me how complex it really is. And it's sort of a lifelong journey to understand it all, either on the scientific side or on the music side.

JEFFREY BROWN: In truth, says Daniel Levitin, we're really in just the infancy of understanding the brain on music, so there's plenty left to do in the lab and reasons galore to "Flip, Flop, Fly" and love music 'til you die.