

IN DEPTH
Science

Music and the brain

Why does a sweet guitar lick give us goose bumps?

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by John Bowman, CBC News

For years, Daniel Levitin worked as a session musician, sound engineer and record producer for rock groups such as The Grateful Dead and Santana.

In 1990, he returned to college to earn a degree in cognitive psychology and later earned a PhD in psychology. Currently, he is an associate professor of psychology, behavioural neuroscience and music at McGill University in Montreal.

His bestselling book, *This Is Your Brain On Music: The Science of a Human Obsession*, comes out in paperback on Aug. 28.

Why did you make the transition from music producer to neuroscience professor?

I'd had these interesting experiences in the recording studio in two realms, and I was driven by a desire to understand how they came about.

On the one hand, going from a novice to being able to hear things in a recording that I didn't know were possible: to be able to hear the difference between one microphone and another just from the sound of it.

I now know a bit more about this phenomenon. I had the inside of my house painted and the painter came in and said, "It looks like you had Benjamin Moore paint the last time." And I said, "How would you know that?" and he said, "It's my job to know. I can tell by the look of it." Benjamin Moore doesn't look like Pratt and Lambert or Sico or Glidden. It has its own look.

People do this in different domains and you kind of take it for granted. You drive your car into the mechanic and he listens and he says, "Your valves are loose." People who are good in their domains acquire this kind of expertise and I was curious about that.

The second part of it was sitting in the recording studio and having Carlos Santana play a solo that gave me goose bumps, and wondering what it is that's going on in my mind that's creating this reaction in me, and what's going on in his mind that's allowing him to transmit these goose bumps to me just by moving his fingers across a piece of wood that has some metal stretched across it? It's surreal at some level.

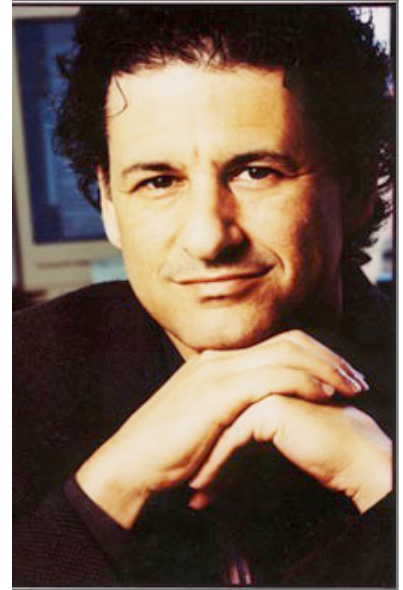
Why does music sometimes give us goose bumps?

At one level, that's the job of the musician. If they didn't do that, at least once in a while, you'd lose interest.

What we do know about the brain side of it, is that there's a network of neural structures associated with the release and uptake of dopamine, including the nucleus accumbens and the amygdala. They regulate dopamine and they're involved with our subjective internal feelings of reward and punishment — fear, reward, pleasure, these primal emotions.

We know that when people listen to music that gives them chills or goose bumps, that these structures are coming online and they're firing and they're recruiting other neurons in the vicinity, actually changing your brain chemistry.

Now why it is that vibrating molecules in the air set in motion by someone blowing into a piece of wood with holes in it, that we don't know.



Daniel Levitin

AUDIO

Is there an evolutionary explanation for the way our brains respond to sound?

[Quirks and Quarks interview with Daniel Levitin, Dec. 9, 2006](#)

Of course, with evolution you're always guessing. You can find fossil records of things like fingers and thumbs and their development, but you don't find fossil records of ideas.

A reasonable story is that sound was a very important sense in our evolutionary history because it allowed you to detect something that was in your vicinity even at night, when you couldn't see it. As well, light doesn't travel around corners; sound does.

The idea that I'm trying to develop in my next book, actually, is that this sense of hearing allowed us to do things like synchronize our behaviour with other humans. Through that came co-operation and social structure.

It's not that we find music and rhythm intrinsically rewarding or intrinsically beautiful, it's that those of us who are alive today are the end chain of a process of natural selection that tended to reward those members of our species that were able to use sound to form social groups and to express emotions that couldn't otherwise be expressed.

We're genetically predisposed to form garage bands?

We are predisposed to form garage bands, in a sense, in that throughout our human history, going back tens of thousands of years, we don't know of any culture that lacked music. There's no culture anywhere today that lacks music. It's found in every society, regardless of their technical or industrialization status.

Babies go through a period of musical babbling, similar to linguistic babbling, where they play around with different contours and pitches and rhythms.

For tens of thousands of years, music making was something that everyone participated in, as far as we can tell, very unlike today, where you have a class of audience members and a class of entertainers. That's a relatively recent phenomenon, evolutionarily speaking.

Why did performers and audience members separate?

The first concert halls were built about 400 or 500 years ago in Europe. Before then, music making was always participatory. Roman coliseums and Greek amphitheatres were for plays, not for music. This idea of a music performance is relatively new.

In the last 100 years since development of recording — it didn't have to go this way, but it did — people, particularly school teachers, became a little bit snooty, and if you couldn't sing as well as this great performance you could buy on a wax cylinder or acetate or tape, you were told not to sing in school. Society has set up this notion that singing should be left to the experts.

Is karaoke an attempt to break down that barrier?

Karaoke is a funny case, because whenever I see it, there's always a group of people giggling nervously. There's this sense that you're doing the forbidden. There's always one person in each group who's not going to go up because they're not even good enough for that.

Of course, part of the fun of it, for people who do this, is to not hear their friend be good, but to hear their friend be bad. This elitism is still there to some extent. Also, it's one person performing for the others, it's not everybody joining in. I think it perpetuates the division.

American Idol is really the epitome of this way of thinking, because everybody gets so much pleasure out of watching the train wrecks and then the expert commentators commenting on the train wrecks.

Why does music come more easily to some people than others?

We don't really know why. There may be genetic factors. When I talk to people like Stevie Wonder or Sting or

Paul Simon, I'm struck by how hard they worked, and they don't feel like it ever came easy. They remember just slaving away at it.

If you accept that there may not have been dramatic differences at the outset, the interesting question becomes, "Why do some people stick with it?" There might be personality factors there, such as tenacity, good old-fashioned stick-to-itiveness, focused concentration. Those might be genetic, but the music itself may or may not be.

When you look at children, they all have different personalities from the get-go. Some are more curious and some are less. Some are louder and some are softer. Some are more active. Some are more passive. There are all these ways in which we differ from one another, and that's due to some combination of environmental factors and genetic factors.

But that's not enough to turn you into a world-class musician. Even if you've got all that predisposition, what somebody might call early music ability or even talent, it takes thousands of hours to become expert at it.

Even when you listen to these so-called child prodigies, most of them are pretty good or even amazingly good for their age, but you're not going to listen to a four-year-old violinist and confuse him with a 40-year-old violinist. It's just that you don't know any four-year-olds that are that good, or even any eight-year-old. But they still have to put in a lot of work.

Why is it that when a new song comes out, we tend to hear it over and over again?

When a song is successful, it has a certain number of surprises in it, not necessarily explicit ones, but implicit, subconscious surprises.

When you're listening to music, what your brain is doing — whether you know it or not and whether you're a musician or not — is constantly trying to figure out what's going to happen next.

With music that has a steady beat, like pop, R&B and hip-hop, your brain doesn't have to work very hard to figure out when the next event is going to happen — that's pretty predictable — but it doesn't know exactly what's going to happen.

The skilful composer manipulates this sense of expectation. Your brain's trying to predict what's coming next, it makes a prediction and the skilful composer will meet those predictions a certain percentage of the time and violate them a certain percentage of the time.

If those violations are done in a clever way and in an interesting way, your brain gets really excited because it's now learned something new. It's learned a new pattern. It incorporates that knowledge, but it's still surprising relative to the thousands of songs that you've heard before that don't do that. And you want to hear it over and over again because it was surprising that first time.

Take the song *Yesterday* by the Beatles. It's got a seven-bar phrase, and almost every other pop song is either four bars or eight bars. Even if I tell you this and even if you've known this for years, the song still is rewarding because, although it's not violating your expectation for that song, it's still violating your expectation for pop songs in general.

