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Why Music Makes Our Brain Sing



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MUSIC is not tangible. You can't eat it, drink it or mate with it. It doesn't protect against the rain, wind or cold. It doesn't vanquish predators or mend broken bones. And yet humans have always prized music — or well beyond prized, loved it.

In the modern age we spend great sums of money to attend concerts, download music files, play instruments and listen to our favorite artists whether we're in a subway or salon. But even in Paleolithic times, people invested significant time and effort to create music, as the discovery of flutes carved from animal bones would suggest.

So why does this thingless “thing” — at its core, a mere sequence of sounds — hold such potentially enormous intrinsic value?

The quick and easy explanation is that music brings a unique pleasure to humans. Of course, that still leaves the question of why. But for that, neuroscience is starting to provide some answers.

More than a decade ago, our research team used brain imaging to show that music that people described as highly emotional engaged the reward system deep in their brains — activating subcortical nuclei known to be important in reward, motivation and emotion. Subsequently we found that listening to what might be called “peak emotional moments” in music — that moment when you feel a “chill” of pleasure to a musical passage — causes the release of the neurotransmitter dopamine, an essential signaling molecule in the brain.

When pleasurable music is heard, dopamine is released in the striatum — an ancient part of the brain found in other vertebrates as well — which is known to respond to naturally rewarding stimuli like food and sex and which is artificially targeted by drugs like cocaine and amphetamine.

But what may be most interesting here is when this neurotransmitter is released: not only when the music rises to a peak emotional moment, but also several seconds before, during what we might call the anticipation phase.

The idea that reward is partly related to anticipation (or the prediction of a desired outcome) has a long history in neuroscience. Making good predictions about the outcome of one’s actions would seem to be essential in the context of survival, after all. And dopamine neurons, both in humans and other animals, play a role in recording which of our predictions turn out to be correct.

To dig deeper into how music engages the brain’s reward system, we designed a study to mimic online music purchasing. Our goal was to determine what goes on in the brain when someone hears a new piece of music and decides he likes it enough to buy it.

We used music-recommendation programs to customize the selections to our listeners’ preferences, which turned out to be indie and electronic music, matching Montreal’s hip music scene. And we found that neural activity within the striatum — the reward-related structure — was directly proportional to the amount of money people were willing to spend.

But more interesting still was the cross talk between this structure and the auditory cortex, which also increased for songs that were ultimately purchased compared with those that were not.

Why the auditory cortex? Some 50 years ago, Wilder Penfield, the famed neurosurgeon and the founder of the Montreal Neurological Institute, reported that when neurosurgical patients received electrical stimulation to the auditory cortex while they were awake, they would sometimes report hearing music. Dr. Penfield’s observations, along with those of many others, suggest that musical information is likely to be represented in these brain regions.

The auditory cortex is also active when we imagine a tune: think of the first four notes of Beethoven's Fifth Symphony — your cortex is abuzz! This ability allows us not only to experience music even when it's physically absent, but also to invent new compositions and to reimagine how a piece might sound with a different tempo or instrumentation.

We also know that these areas of the brain encode the abstract relationships between sounds — for instance, the particular sound pattern that makes a major chord major, regardless of the key or instrument. Other studies show distinctive neural responses from similar regions when there is an unexpected break in a repetitive pattern of sounds, or in a chord progression. This is akin to what happens if you hear someone play a wrong note — easily noticeable even in an unfamiliar piece of music.

These cortical circuits allow us to make predictions about coming events on the basis of past events. They are thought to accumulate musical information over our lifetime, creating templates of the statistical regularities that are present in the music of our culture and enabling us to understand the music we hear in relation to our stored mental representations of the music we've heard.

So each act of listening to music may be thought of as both recapitulating the past and predicting the future. When we listen to music, these brain networks actively create expectations based on our stored knowledge.

Composers and performers intuitively understand this: they manipulate these prediction mechanisms to give us what we want — or to surprise us, perhaps even with something better.

In the cross talk between our cortical systems, which analyze patterns and yield expectations, and our ancient reward and motivational systems, may lie the answer to the question: does a particular piece of music move us?

When that answer is yes, there is little — in those moments of listening, at least — that we value more.

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