Did Humans Invent Music?
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Introduction:
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Did Neanderthals sing? Is there a "music gene"? Two scientists debate whether our capacity to make and enjoy songs comes from biological evolution or from the advent of civilization.

Music is everywhere, but it remains an evolutionary enigma. In recent years, archaeologists have dug up prehistoric instruments, neuroscientists have uncovered brain areas that are involved in improvisation, and geneticists have identified genes that might help in the learning of music. Yet basic questions persist: Is music a deep biological adaptation in its own right, or is it a cultural invention based mostly on our other capacities for language, learning, and emotion? And if music is an adaptation, did it really evolve to promote mating success as Darwin thought, or other for benefits such as group cooperation or mother-infant bonding?

Here, scientists Gary Marcus and Geoffrey Miller debate these issues. Marcus, a professor of psychology at New York University and the author of Guitar Zero: The New Musician and The Science of Learning and Kluge: The Haphazard Evolution of The Human Mind, argues that music is best seen as a cultural invention. Miller, a professor of psychology at the University of New Mexico and the author of The Mating Mind: How Sexual Choice Shaped the Evolution of Human Nature and Spent: Sex, Evolution, and Consumer Behavior, makes the case that music is the product of sexual selection and an adaptation that's been with humans for millennia.

Gary Marcus: We both love music and think it's important in modern human life, but we have different views about how music came to be. In Guitar Zero, I argued that music is a cultural technology, something that human beings have crafted over the millennia, rather than something directly wired into our genomes. Why do you think music is a biological adaptation?

Geoffrey Miller: Music's got some key features of an evolved adaptation: It's universal across cultures, it's ancient in prehistory, and kids learn it early and spontaneously.

Marcus: "Ancient" seems like a bit of stretch to me. The oldest known musical artifacts are some bone flutes that are only 35,000 years old, a blink in an evolutionary time. And although kids are drawn to music early, they still prefer language when given a choice, and it takes years before children learn something as basic as the fact that minor chords are sad. Of course, music is universal now, but so are mobile phones, and we know that mobile phones aren't evolved adaptations. When we think about music, it's important to remember that an awful lot of features

that we take for granted in Western music—like harmony and 12-bar blues structure, to say nothing of pianos or synthesizers, simply didn't exist 1,000 years ago.
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Miller: Sure, and other things like the pentatonic scale and the verse-chorus-bridge structure of pop songs aren't as universal as most people think.

Marcus: I think it's deeper than that. Pentatonic scales are fairly common, but what we think of as music isn't what our ancestors thought of as music. Virtually every modern song revolves around harmony, but harmony is an invention that is only a thousand years old. Even if you ignore electric guitars and synthesizers, there is still some fairly significant difference between virtually all contemporary music and the music that people listened to a few thousand years ago.

Miller: A lot of music's features vary across cultures, especially in elite/pretentious music like Arnold Schoenberg, Indian ragas, or Chinese opera. But every culture includes singing, drumming, and dancing, and many aspects of folk music look fairly universal, such as rhythm, dance, pitch contours, scales, structural repetition, and timbre changes to express emotion.

Marcus: When ethnomusicologists have traded notes to try figure out what's universal about music, there's been surprisingly little consensus. Some forms of music are all about rhythm, with little pitch, for example. Another thing to consider is the music is not quite universal even with cultures. At least 10 percent of our population is "tone deaf," unable to reproduce the pitch contours even for familiar songs. Everybody learns to talk, but not everybody learns to sing, let alone play an instrument. Some people, like Sigmund Freud, have no interest in music at all. Music is surely common, but not quite as universal as language.

Miller: Let's come back to the age of music. The bone flutes are at least 35,000 years old, but vocal music might be a lot older, given the fossil evidence on humans and Neanderthal vocal tracts. Thirty-five-thousand years sounds short in evolutionary terms, but it's still more than a thousand human generations, which is plenty of time for selection to shape a hard-to-learn cultural skill into a talent for music in some people, even if music did originate as a purely cultural invention. Maybe that's not enough time to make music into a finely tuned mental ability like language, but nobody knows yet how long these things take.

Marcus: Thirty-five-thousand years is certainly enough time to evolve some simple genetic tweaks like lactose tolerance, but lactose tolerances depends on just a few enzymes. Whether or not Neanderthals sang, music remains relatively recent in evolutionary terms, less than a 10th of a percent of the time that mammals have been on the planet.

Miller: What about the fact that responsiveness to music starts in the womb, and kids show such a keen interest in music?

Marcus: My best guess is that early interest in music is parasitic on language. We're born to listen for language, and music sounds sort of like language, so kids respond. But given the choice, infants prefer speech to instrumental music, and my lab's research suggests that they analyze language more carefully than music.

Miller: But most kids aren't passionate to learn about most purely cultural inventions, like chess or algebra.

Marcus: Lots of kids are passionate about chess, and even more about other cultural inventions like baseball and video games, to say nothing of Pixar videos. Video games, television shows, and iPhones are all cultural artifacts that were shaped to be irresistible to human brains, and that provoke strong emotions like music, but that doesn't mean that human brains were shaped to be attracted to them. I think of talented musicians as being like Steve Jobs: grand cultural engineers who design entertainment technology that appeals to brains that evolved for millions of years before the technology was developed.

Miller: So you're not much impressed that neuroscientists have identified some key brain areas that are active when hearing or performing music?

Marcus: Music is spread very broadly throughout the brain. There doesn't seem to be any part of the brain that is fully dedicated to music, and most (if not all) of the areas involved in music seem to have "day jobs" doing other things, like analyzing auditory sounds (temporal cortex), emotion (the amygdala) or linguistic structure (Broca's area). You see much the same diversity of brain regions active when people play video games. Face recognition has a long evolutionary history, and a specific brain region (the fusiform gyrus) attached, but music, like reading, seems to co-opt areas that already had other functions.

Miller: I guess we can agree that we need a lot more evidence from genetics and neuroscience before there's an ironclad case for music being a biological adaptation. But there's also the psychological evidence. Music isn't just compelling to the listener; musical performance is also romantically attractive in a way that playing video games isn't.

Marcus: This leads to your sexual selection explanation for music. Can you explain how that works?

Miller: Darwin argued that music evolved mainly by sexual selection through mate choice—and that we're uncomfortable acknowledging that fact. He wrote back in 1871 that, "The impassioned orator, bard, or musician, when with his varied tones and cadences he excites the strongest emotions in his hearers, little suspects that he uses the same means by which his half-human ancestors long ago aroused each other's ardent passions, during their courtship and rivalry." He knew that music didn't need to have a "survival value" for the individual or the group; it could spread through purely reproductive benefits. He suggested that the more musically talented proto-humans attracted more sexual partners, or higher-quality sexual partners, than their less-musical rivals. We see sexual selection for music in many other species—insect song, frog song, bird song, whale song, and gibbon song—so I think that's a reasonable default theory for how humans evolved music. It's the theory to beat.

Marcus: I have no qualms about assuming that music was selected for in some species, like many songbirds. It's human music that I'm skeptical about. In most songbirds, only the males sing, not the females. Are you suggesting that men are more musically talented than women?

Miller: No, that's what Darwin might have argued, but it's not my claim. The traditional way to show that sexual selection shaped a trait is to look for big sex differences in the trait. But that's a bad strategy when you're dealing with a mutual-choice species like ours. In humans, both sexes are choosy—at least about forming the long-term relationships that produce most children—and both sexes display behavioral ornaments to each other, from music, arts, and jokes, to religious ideologies and moral virtues. You see a lot of music in semi-monogamous songbirds and gibbons too, with both sexes singing. So it's a mistake to assume that sexual selection for music

required proto-Hendrix virtuosos to attract hundreds of female groupies. All you need is ancestors who fell in love partly on the basis of musical talent, among many other romantically attractive traits. I imagine prehistoric equivalents of Joni Mitchell and Graham Nash (of Crosby, Stills, and Nash) falling for each other. Any good theory of music evolution has to explain the musical genius of Kate Bush and Bjork as well as it explains Beethoven and Beck.

Marcus: But even if you had mutual-mate choice for music, wouldn't you expect dedicated neural circuits for music, like the brain areas for song learning and song production in songbirds, hummingbirds, and parrots, that don't exist in non-singing birds?

Miller: Maybe, if we evolved music millions of years ago like they did. But since we're the only great apes with any aptitude for rhythm or melody, human music is probably much more recent: not enough time for such specialization of brain structure. And the songbirds never evolved language. If they had, we'd probably see overlapping brain areas for music and speech in their brains, just like ours. Which would have led their scientist-songbirds to argue that birdsong is just a side-effect of birdspeech.

Marcus: That doesn't seem like the most compelling argument. Is there any more principled way to explain why so much of the human brain is involved in music?

Miller: I think so. One counterintuitive principle is that for sexually selected mental traits like music to work well as signals of general brain function and intelligence, they need to recruit a lot of different brain areas and mental abilities. Otherwise they wouldn't be very informative about the brain's general health. If musical talent didn't depend on general intelligence, and general mental health, and general learning ability, it wouldn't be worth paying much attention to when you're choosing a mate.

Marcus: Of course, video games use up lots of different brain areas, too. I can see an argument that any complex skill might be a signal for general brain function, and agree that people might choose their mates based on that signal, but that doesn't mean music per se was selected for. People might equally choose their mates based on SAT scores, but that doesn't mean the brain evolved for taking SATs.

Miller: Yet SAT scores aren't romantically attractive the way that love songs are. Content analyses show that pop song lyrics have usually concerned lust, love, or jealousy—around the world, at least throughout the 20th century. There's an emotional resonance to courtship music that you just don't see with purely cultural inventions.

Marcus: So why haven't we found any genes that are specifically tied to music?

Miller: That's not surprising from a sexual selection perspective. For music to work as a "good genes" indicator in mate choice, music needs to recruit a lot of different genes and gene-regulatory systems and biochemical pathways. You shouldn't expect just a few "music genes" that explain most musical talent, but thousands of contributing genes. But that's not why we haven't found any music genes yet. Nobody's really looked. There's very little gene-hunting work on music, and hardly any twin research on the heritability of musical talent.

Marcus: Actually some people have looked, and there are a handful of candidate genes—genes that seem to be correlated with musical ability, but perhaps none that are truly specific to musical ability. A 2009 study showed the vasopressin gene AVPR1A is correlated with musical ability, but AVPR1A seems to correlated with lots of other things, too, ranging from creativity to

sexuality. There are probably tons of genes that can help someone become musical, but that doesn't mean any of them was specifically selected for because of their role in music. If you have genes that lead you be curious, or to have nimble fingers, that's going to make you a better musician, but that doesn't mean that the history of which ancestors reproduced and which didn't depended on who was more musical.

Miller: There are two kinds of music genes that could matter: the music-talent genes that explain individual differences in musical talent among humans, and the music-capacity genes that explain why we have musical abilities at all compared to most other mammals. The music-talent genes might number in the tens of thousands. We already know there are more than half a million DNA base pair differences that contribute to general intelligence differences between people, and a similar number might influence musical intelligence. But those music-talent genes will be much easier to identify using standard molecular genetics methods.

The music-capacity genes that distinguish musical humans from non-musical chimps might be far fewer in number, but much harder to identify. If we can identify them though, and if they also exist in the Neanderthal genome (which is being pieced together now from fossil DNA), we'd know that music is probably at least 200,000 years old, because we diverged from Neanderthals by then. So it's true that music doesn't fossilize, but we still might learn when music evolved from the genetics.

Marcus: If we could really show decisively that Neanderthals could sing, that sort of genetic evidence would certainly help, but unless we find genes that are specifically tied to music, it might be hard to go on in the other direction: to deduce whether Neanderthals can sing based on their genomes. Chimpanzees are much less interested in music than humans are, but we still haven't been able to link that to a particular genetic difference. Maybe someday!

Miller: Until then, I'll enjoy Tori Amos and Buckethead as pinnacles of sexual selection.

Marcus: And I'll enjoy Stravinsky and Jimi Hendrix, genius cultural engineers who learned to push our brain's pleasure buttons in brand-new ways.