Why We Sing: An Ode to Our Musical Origins

by

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ABSTRACT

Music is part of human culture and has been around for several thousand years. In spite of its strong emotional appeal, the history of this human characteristic, and the source of its allure remain elusive. This thesis is a report from the frontlines of research into the origins of human music, presenting four popular scenarios for the source of music. Music is treated as a homolog for gibbon song, as a co-evolver with language, as a sexually selected adaptation and as a cultural artifact that elicits universally reaching, culturally exclusive emotional responses from listeners.

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Why We Sing: An Ode to Our Musical Origins

The curtain rose at the end of the MET's 2010 production of Georges Bizet's *Carmen.* The lead mezzo-soprano flounced onto stage in a black gown that hugged her torso and crept up her left shoulder in a single red and black strap. From the highest circle of the gallery at the Metropolitan Opera, the singers on stage, bowing for the trilling audience, looked like elaborately dressed chess pieces. Carmen stood out from the crowd. Her bodice, covered in a rash of sequins, shimmered as she moved. Flaring at her knees, the lightly ruffled black material trailed like plumage plucked from a large black bird, and splayed behind her as she walked up to the front, holding hands with the tenor who played her lover in the opera. The two took a deep bow for the audience.

In the past four hours, Carmen had sung, danced, climbed tables, and seduced soldiers on stage. In the closing scenes she'd been stabbed by her jealous lover, and "died" within a few bars of the opera's close. The audience was in raptures. They gave Carmen and the rest of the cast of the opera a standing ovation.

Running an opera is an elaborate affair. It is an expensive operation to maintain, serves no apparent use other than to entertain, and is something a large section of the Western society enjoyed as their principle mode of entertainment when it first began in the early 17th century.

Biologists read the larger faculty of music in much the same way: it is an expensive operation, taxing several large portions of the human brain. Music holds universal appeal. It has as endured through history for at least 35,000 years and all human beings make or experience music in some way. And yet, music serves no apparent biological function. A question that has festered in the minds of scientists and evolutionary biologists who study the brain has been: why did human beings create music? When did it first evolve? Did it evolve at all?

The search for the truth about music's origins began as early as 1871. In that year Charles Darwin proposed a few early ideas for the function of music when he published a companion volume to his *Origin of Species*, called *The Descent of Man.* In this, he applied his ideas about evolution to human beings. In a small section, he addresses the musical faculty. "I conclude that musical notes and rhythm were first acquired by the male or female progenitors of mankind for the sake of charming the opposite sex," he says, indicating that evolutionary need and reproductive success was behind its creation.

Roughly a hundred years after Darwin wrote *Descent*, Steven Pinker published his own take on the origin and function on music. As he sees it, music is nothing but "auditory cheesecake," a pleasure device evolved by a powerful brain. Rather than serving a role in sexual selection, driving the reproductive success of the species, Pinker argued that music in human beings was neither useful nor necessary. It was a chance by-product of a bored brain – an accident.

Darwin's and Pinker's views represent two extreme takes on the possible functions of music. Entwined with these two approaches are two alternate histories for the origin of music. Darwin's theory would claim that music in some form appeared on the scene at the same time, or earlier than language did. Pinker's claim suggests music came much later than language, emerging fairly recently as a product of hedonistic brain. In between these extreme theories a bevy of sociological, linguistic and archaeologically rooted alternate explanations. These range from the purely biological, to theories rooted in the particular circumstances and idiosyncrasies of human cultures.

In four acts, this thesis presents four of the most popular cases for where music came from – a report from the front lines of the struggle to answer that seemingly simple question: where did music come from?

Gibbon Love Duets

There is a concert on in the siamang pen at the Dormand Zoo in Germany. Two siamangs, a male and a female, sit facing each other high atop the wooden scaffolding erected in the center of their pen. Arms covered in thick black fur grip the wooden beams overhead, and each adult sways slightly, watching the skittering of a siamang youngster that swings on the beams from one adult to the other, then back again. Khaki colored pouches rise out of the black fur on their neck, swelling and bulging as they hoot in response to one another. As the concert progresses, the siamangs begin to groove to the rhythm of their song. They leap up, swing around the beam and wave their arms.

Siamangs are the loudest and largest of the gibbons – a family of black-furred apes that are native to East and South Asia. Gibbons are tree swingers, leaping and swinging up to 8 meters, at speeds that can reach 35 miles per hour. Of all the singing gibbons, the siamang makes the loudest, most complex call.

Thomas Geissmann, a researcher at Anthropological Institute, University Zürich-Irchel in Switzerland, calls this siamang duet, characteristic of a mated pair of siamangs, the closest the animal kingdom gets to what we understand as a "love song." Investigating this group of primates, Geissmann believes, yields clues to the origins of human music.

In 1979, a 22 year old Geissmann was working towards a master's degree in animal behavior at Zurich University. Walking through the Zurich Zoo one day, he was distracted by what sounded like a dogfight coming from the siamang pen. The black-furred primates prowled through the massive cage, throwing branches, and smashing their bodies against the wire mesh of the fence in time to the calls. As they hooted, the bulbous sack under their chin swelled and deflated. Geissmann was captivated. The sheer volume of their calls blew him away. As he watched, he realized that the siamang calls, which lasted up to fifteen minutes, were not random. They followed a well-coordinated sequence: a call-and-response duet punctuated by movement. Geissmann realized he was watching a well-rehearsed performance. He decided then, he wanted to study the gibbon duet.

In the early eighties research on siamangs and gibbon song was sparse. A lone paper published by the Swiss animal behavior expert, Juerg Lamprecht, described the first sighting and recording of call and response duets in gibbons. Geissmann went home from the zoo and made a list of everything he would like to study about gibbon duets, tucked the list away, and went back to class at the Anthropological Institute.

About the time Geissmann began thinking about gibbon duets, the International Psychological Congress held their annual convention in Zurich. Chancing by the program, Geissmann noticed that Lamprecht was going to be there.

"And I saw his name and thought, 'Wow he has written *the* paper on siamang call in 1970,'" Geissmann recounts, "I thought, 'I really have to see this guy, and I took a note of when this talk was, and sneaked into his presentation.'" Sidling up to the senior scientist after his session, Geissmann described his interest in gibbon song, and made an appointment to talk before the conference was over.

The two met over coffee. "He was really nice, and let me talk for a while," Geissmann says. When Geissmann had finished, and listed his three ideas for research, Lamprecht urged Geissmann to follow his idea about the mate-specificity of gibbon duets. "And he went so far as to say, 'Well, if you have finished your data collection, give me a call – maybe we can invite you to come to [the Max Planck Institute] to analyze your data there,'" says Geissmann, "And I thought, 'This is a fantastic opportunity.'"

Geissmann spent the next five years working on his diploma thesis. Still in Switzerland, he watched and recorded siamang pair duets at the Zurich Zoo in the early mornings, then headed back to the university to attend lectures in behavior and anatomy. When he had collected his data, he called Lamprecht. Lamprecht invited him to the Institute in Germany and installed Geissmann in a cabin overlooking a lake, with just enough space for a bed and a desk. Geissmann stayed in this cabin for months, analyzing and interpreting recordings during the day, and falling asleep to the night-calls of geese and badgers. At the end one year, he had a report that established, for the first time, the importance and uniqueness of duets in building relationships among gibbon pairs.

"The coordination of song is something that occurs very rarely among mammals… And duetting, even more so," says Geissmann, "this something you find among apes only in gibbons and in humans." Pairing for life, siamang couples develop well-honed routines that establish their relationship with one another. A well-developed duet warns other siamangs that the two are a pair. In the early stages of courtship, broken, clumsy duetting is a signal to the rest of the family that the duetting siamangs are emerging as a couple. Geissmann's data reveals that robust, well-rehearsed routines between duetting siamangs are an indication of a long and healthy relationship.

On first hearing siamang song, most people mistake the pitched hooting for birdsong. "If you play a tape recording of a singing crested [gibbon] to someone who doesn't know what they are listening to, and you ask them 'What is this?' then they say, it is bird song. [Yet] it is an ape doing this." But, unlike birdsong, gibbon singing is not a mating call. It serves to express and establish a connection between the duetting gibbons.

The gibbon duet varies greatly among species. Geissmann can distinguish siamangs based on their call. "You recognize what species you are listening to," Geissmann says, "and even learn to identify individuals." While the siamang duet is lower and deeper, other species, like the crested gibbon have high-pitched melodious vocalizations. These "songs," Geissmann stresses, are tonal. "The adult animals not only have a repertoire of a variety of different notes that can be easily classified and told apart from each other, they have two repertoires – one for the female and one for the male," says Geissmann, "When they put together their repertoires in a duet, [this] means that each individual knows what note it has to answer after the note of the partner."

Gibbons are social primates. Usually monogamous, they live in family units of two parents and one or two infants. Once the offspring are mature, they are eased out from the family group. The lone youngster then looks for a mate, and settles down to sing.

The species and sex-specificity of gibbon song as described in Geissmann's first works suggests that singing in these primates usually develops between gibbon pairs. Geissmann believes that the song also serves a larger function – to reinforce the sense of community that comes with living in a family. Geissmann says that singing occurs through the entire family unit. When there are offspring, little siamangs chirp in like a choir. "In a family group, you have not only have adult pairs, you also have offspring," Geissmann says, "and very often offspring chime into the duet, so as to produce a concert."

As he continued to study gibbon "song," Geissmann began to note a resemblance to human music. For one, the notes that the gibbons sing are produced at a very specific pitch. Also, there is a clear structure to their melodic phrases. "Singing means producing different types of notes in a predetermined, *syntactical* phrase," says Geissmann, "[In gibbons] you have phrases that can be recognized, and the phrases and ordered in a particular sequence. The notes are tonal – not sounds – tones."

Gibbons are never still when they perform. Geissmann says that just as "[i]t is very difficult to listen to Benny Goodman without slightly moving your feet to the rhythms," gibbons freely punctuate their calls with coordinated, repeated physical motions. These locomotive embellishments are not random – rather, like the well-structured song phrase, the movement is rehearsed. For example, researchers recently recorded the song of one white-handed gibbon at the Zoo Seeteufel in Studen, Switzerland, who had taken to slamming a door to punctuate the climax of her call. "There's a certain part of their song where they have to burst into locomotion," Geissmann says, "They *must* do it." He says that the need to foot-tap or beat rhythm is a tendency that, like in the gibbons, evolved in human beings as well. "The fact that there is music that is so hypnotic for the listener that it is difficult to sit still suggests that there is an inborn element in humans that reacts to music," Geissmann says, "And this inborn quality is the same thing that happens in primates when they produce a loud call, or gibbons when they sing."

To Geissmann, such echoes between the structure of the gibbon duet and human music hint at a common origin. Human beings and gibbons share a common primate ancestor. Geissmann believes this ancestor could sing. Then, as gibbons and humans diversified through a series of speciation events, their song changed.

Biologists call features which share a common ancestor "homologs." For example, the wings of the bat and the wings of the bird are homologs, both sharing an origin in the vertebrate forearm. Over time, a homolog could change, retaining some features of the original trait, and losing others. According to Geissmann, human music and gibbon song are homologs that originated in an ancestral singing primate.

Geissmann calls the first song the Loud Call. He imagines that the Loud Call evolved in primates as they began to form groups. It would have been the first form of communication. Versions of the Loud Call would have signaled territorial boundaries, or warned of approaching danger. Geissmann sees structural similarities between gibbon song and the territorial and alarm calls of non-singing primates. "The loud calls of early hominids may have been the substrate from which human singing and, ultimately, music evolved," Geissmann writes in an article in *Origins of Music*. Human music was born of this call, and then diversified to involve rhythm, melody, and the like. "I think it is a homolog," Geissmann says.

But our early primate ancestor was no Frank Sinatra. His singing was an announcement of the location of food, or the location of certain members of the social group. And most importantly, Geissmann says, it kept the group together. "The most widely distributed … and probably the most likely function of early hominid music," Geissmann says in *Origins*, "is to display and possibly reinforce the unity of a social group toward other groups." Geissmann sees lingering evidence of this function in human music today. "National hymns, military music, battle songs of fans and cheerleaders encouraging their favorite sports teams, or the strict musical preferences of youth gangs we may be continuing what an early primate ancestor started a long time ago," he says.

As far as homologs go, music is an oddity. Most homologs leave a fossil trail behind them, and archaeologists are able to piece together their evolutionary history. But music does not fossilize. "I suspect it is a homolog but I can't prove it," Geissmann says, "… these lineages have diverged from each other such a long time ago, that the few similarities in the calls you find could be just coincidences. Or, they could be the evidence for a common ancestor. It's difficult to be sure."

So, while Geissmann's theory is plausible, hard evidence of the course of evolution that he proposes is impossible to come by. Origin seekers who are unsatisfied with theorizing must turn elsewhere. Looking for palpable answers to the origins of human music, some are turning to its direct source – the human brain.

Everything Above the Neck

The human brain likes blood. Three thick arteries spring from the main aorta leaving the top of the heart and creep in parallel up, behind the nose, entering the brain at the base. They quickly fork and divide into a fine mesh of branches that sluice every neuron in the brain with blood and fresh oxygen. Soaking in 14 per cent of body's total blood volume, the brain is a thirsty organ.

A blockage of the blood supply to the brain can have dangerous effects. Sometimes clots that form in the blood could travel through the circulatory system and snag in the brain, clogging the blood flowing to a section of neurons. For every minute that the artery is blocked and blood flow is stopped, two million brain cells die.

This is a stroke – a "brain attack," much like a heart attack. Strokes afflict 137,000 Americans a year. When a stroke attacks the Broca's area in a person's brain, it affects their ability to read, write, and speak. This condition, called aphasia, can range from the total inability to form sentences, to the difficulty forming some words when speaking. One in every 272 Americans is affected by some form of aphasia.

Researchers who study and treat aphasia in people are now being surprised by the connections to be found in the musical and linguistic capacities of patients suffering from aphasia.

Michael* is fifty-eight today. He sits at a table in spare room with filing cabinets in a corner, and hospital-blue walls. His therapist, Andrea, sits across from him. Today's lesson is going to prepare Michael for summer.

A year ago, Michael suffered a stroke in the left side of his brain, which killed the neural pathways connecting his auditory and speech processing centers. He lost the ability to speak even basic sentences and was diagnosed with aphasia. Researchers at the Schlaug lab at the Beth Israel Center in Boston, Massachusetts are using music to help Michael speak again.

Andrea begins: "If it's hot outside, you might want to have a drink. You'd say, 'I am thirsty.'"

Though Michael has lost the ability to speak, he can still hear perfectly, and understands Andrea's words. But, when tries to repeat her sentence, he does not move past the first word.

Now Andrea reaches out and places her hand on Michael's resting on the table. She hums a note, lips closed over a "Hmm."

Primed, Michael awaits instruction.

Taking a deep breath, Andrea begins to sing a melodic phrase four notes long, beginning on the note she hummed less than a minute ago.

"Hmm – mm – *mm* – mm."

Andrea raises the pitch of the third note a musical half-step, then returns to the original pitch for the fourth note. In time with each note, she taps Michael's hand.

This time Michael follows perfectly, humming the four-note musical phrase in response. Andrea leads and Michael repeat their duet twice more.

Now Andrea uses words.

"I – am – *thir* – sty," she sings, in the same that she hummed her first four-note musical phrase. She raises the pitch of the third syllable of the sentence.

Michael follows her, singing out loud, "I – am – *thir* – sty."

Now Andrea reverts to speech, talking through the phrase, emphasizing the third syllable only slightly.

Michael has sung through the phrase three times, and it is now time for him to speak.

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* Name changed to protect the privacy of the patient

"What would you say when it's hot outside, on a day like today?" Andrea asks.

This time unflinching, Michael replies, "I am *thir*-sty."

Gottfried Schlaug is a doctor, neuroscientist and music enthusiast. At Harvard Medical School and the Beth Israel Center, he directs the Music and Neuroimaging Laboratory that studies musical activity in the brain. Andrea's adviser, he presented the results of Michael's therapy via video at a recent conference in San Diego.

For the pass 100 years, individual therapists treating aphasias of various kinds found that singing helped stroke victims talk again. As they sang, patients appeared to create new connections to replace the ones that their stroke had killed. Researchers and aphasia therapists call the process of learning through singing Musical Intonation Therapy, or MIT. Schlaug is spearheading one of the first attempts to study and image the neural connections between areas in the brain that control singing and speaking, as MIT helps stroke victims talk again.

Schlaug and team imaged the brains of aphasics before, during and after therapy sessions. After a stroke caused a lesion in the left side of his brain, one patient lost the ability to speak, and could not even speak his house address. 75 sessions of therapy later, he could. As this patient went through therapy, the researchers at the Schlaug lab saw his brain morph and change in front of their eyes.

"Those structural changes that we have seen in these patients," Schlaug announced at a recent conference, "mirrors some of the structural differences that we see in professional singers compared to vocational singers."

Michael's experience with his therapist, and examples of progress from other patients through clearly shows a link between music and language in the brain. To what extent are the music and language processing faculties linked? Thinkers have used two methods to get to the bottom of this association. First, they looked at the structure of music and language, as creative products of the brain. Then, they looked back at the brain to see how it processed and created the two faculties.

In the fall of 1973, the American composer Leonard Bernstein gave a series of six lectures at Harvard University. He addressed the audience seated around him in a circle, from a desk at the center of the stage. For the first time, over the course of these lectures, Bernstein presented the idea that there might be a strong similarity between music and language – a universality in structure, where a set of notes would be governed by a set of grammatical rules. "Whither music?" he asked. "Even to guess at the answer to 'whither music' we must first ask, 'Whence music? What music? and Whose music?'"

Bernstein's remarks sparked a flurry of activity in the linguistic community in Boston. In the fall of 1974, a faculty seminar was organized at the Massachusetts Institute of Technology to further discuss possible structural parallels between music theory and linguistics. Composer Fred Lerdahl and Brandeis University linguist Ray Jackendoff, had both attended Bernstein's lectures at Harvard less than a year ago, and signed up for the project. Collaborating over the course of the seminar, they subjected Bernstein's propositions to rigorous linguistic and musicological analysis. Together, they wrote up their conclusions, for the most part dismissing Bernstein's tantalizing proposal. "… if substantive parallels between the theories emerge (as they infact have in a number of areas)," they wrote in 1981, "they are to be regarded as simply an unexpected bonus."

Thirty years later, new evidence shows that Bernstein could have been right.

"In a sense the work we're doing now does support Bernstein's general idea – it doesn't support the *details* of his idea about how you precisely map language onto music," says Ani Patel, "But it does support the general idea of some kind of connection between the grammar of language and the grammar of some types of music."

Imaging studies on language and music processing suggests music and language in the human brain might actually be powered by shared neural machinery. If so, there is a strong chance that music and language might have evolved together.

Patel studies music and the mind at The Neurosciences Institute in San Diego, California. He began his career studying ants. A graduate student in biology at Harvard, he was interested in animal behavior, evolution and ecology. Out in the field in Australia on an ant project, he realized he wanted to study music. He called up researchers in Montreal, at Tufts University, at the Max Planck Institute in Germany, and at the linguistics department at MIT, and began his study of musical faculties in the brain. Now an expert in the area, he recently published a book, *Music, Language and the Brain,* in which he talks about some of the similarities between music and language.

Patel looks at how the brain responds to language and music, while at the same time looking at music and language as products of the same brain. Like Schlaug, he is also interested in the brain of patients with aphasia, but his focus, like Berstein's, is on musical grammar.

"No culture makes music by randomly combining notes," says Patel. Though notes do not convey any information, individual notes only make sense to us when they are placed in a longer sequence. A single note may seem "stable" or "unstable" depending on the musical context in which it occurs. Patel had a strong suspicion the language and msuical grammar processing systems in the brain might be close together.

To test this idea, he tested aphasics – the same group of people who Schlaug studied because their language grammar processing centers had been turned off – for music comprehension.

Can Anne scratch a door with a tomato?

Let's think about this for a minute. What is Anne doing? Scratching a passing door. What is Anne using to scratch the door? A tomato. As we make sense of the words in the first sentence of this paragraph, our brains are munching through a sequence of events that Patel calls "semantic processing." People with Broca's aphasia typically have a hard time with this, and fail to recognize the absurdity in the sentence – something a healthy person will almost immediately recognize.

Now consider the two-note theme from the movie *Jaws*. Chances are, if you heard either of those notes played by themselves, you would attach no importance to either of them. But, strung together, the sequence recurring through the film: *ba*-dum, *ba*-dum, strikes most people as inescapably ominous.

Patel and his team put a group of 12 Dutch aphasics through a series of linguistic and musical tests like the two above. As aphasia is known to affect the language processing centers in the brain, Patel expected the group to have difficulty identifying grammatical flaws and semantic oddities in sentences. So far, so good.

Then, the researchers played musical phrases to the same subjects. The sequence expressed a "happy" (major) or "sad" (minor) theme, with a sour note among the sequence, which did not fit the "happy" or "sad" theme. To their surprise, Patel and team found that aphasics were unable to process the implicit grammar of the music, and unable to identify the notes which were out of place in the sequence. The region of their brain which researchers had only identified as being turned off to language, it turned out, also affected musical perception.

This, Patel writes, is "evidence that the grammatical processing of language and music overlaps in the brain."

The fact that music and language share parts of the brain suggests that the two share an evolutionary history. But, this still leaves open the question of how either or both first emerged. Did music and language evolve together, making their appearance at the same time in evolutionary history? Did one come first? Then, did human beings sing first, or talk?

According to one theory, it all began 3 million years ago, with Lucy.

In 1974, digging in the Hadar region of Ethiopia, archeologists uncovered a nest of about 300 hominid fossils belonging to the group *Australopethecus afarensis.* Of these, the most complete skeleton was made of about 100 bones. They called the female hominid "Lucy." Just over three feet tall, Lucy is our most famous ancestor.

Lucy and her ilk parted ways with primates some 6.5 million years ago. They were still tree dwellers. About 3 million years ago, they let go of the forest branches and settled on the open grasslands of the African Savannah.

Hominids' bodies changed as they moved to the fields. They began to walk on two feet. Their posture changed, opening up and widening their torso and rib cage. We now know that the larger apes are, the more likely they are to congregate in groups. With shrinking teeth and growing brains, A. afarensis, just over 3 feet tall, began living in larger and larger groups of up to 80 or 90 members.

While in the trees, like other primates, they expressed their affection for one another through elaborate grooming rituals. With a group the size of the Australopithecus hunting party on the African savannah, grooming was not enough to keep the group together.

So, anthropologists Leslie Aiello and Robin Dunbar suggest, A. Afarensis may have invented "vocal grooming."

In this telling, Lucy's family's swelling brain would have developed a substitute for the physical grooming which was no longer possible among the large herd. Social bonding based on physical contact changed to bonding based on voiced signals. This was useful in two ways. First, it allowed several members of the group to connect with each other by speaking. Importantly, it allowed them to form bonds while doing other things, like hunting, or picking plants.

Vocal grooming, characterized by its emotional content and its tonality, bore the marks of early music, says Steven Mithen, an archeologist at the University of Reading, in his book, *The Singing Neanderthal.* "Aiello and Dunbar's characterization of vocal grooming in its earliest stages is in fact much closer to song than speech," he says, "for they prioritize its tone and emotional content over its information content." Thomas Geissman's Loud Call had been reborn.

As Mithen reconstructed the story, Australopethecan communication exhibiting the tonality of music and information of language would eventually split up and become music, carrying the emotional information, leaving language to lift the informational load of hominid communication.

His historical reconstruction of early hominids' speaking and singing habits drew on earlier work by Steven Brown, director of the Neuroarts Lab at MacMaster University in Montreal, Canada. In 1997, Brown coined the term "musilanguage" and proposed that music and language had common roots, just based on their internal structures. That common ancestor – the musilanguage – would have been able to communicate information (in the way language does today) as well as emotion. Over time, these two faculties diverged, to develop into the form that they exist in today.

Though Brown and Mithen tell a coherent story of the story of music and language, they have their detractors. In 1997, Steven Pinker, then psychologist at MIT, proposed that music was a very recent, completely useless invention of human beings. "What benefit could there be to diverting time and energy to the making of plinking noises, or to feeling sad when no one has died?"

"I suspect that music is auditory cheesecake, an exquisite confection crafted to tickle the sensitive spots of at least six of our mental faculties," he says in his book *How the Mind Works.* To Pinker, music is best understood as a "pure pleasure technology," merely an ornament created for its own amusement by a plush and energy-rich brain.

Pinker's argument goes something like this: if music is not an adaptation – something that affects reproductive success and can be recognized by selection – then its origin is an accident, a byproduct of the evolution of something else. In Pinker's view, music is merely an ornamental offshoot of the same neural apparatus that produced language.

So what is the last word on the evolutionary relationship between music and language? While of the research community is divided over the question of cultural frill and evolutionary adaptation, Ani Patel suggests that there's a third option. "I would like to suggest that the choice between adaptation and frill is a false dichotomy, and that music belongs in a different category." It has to do with the uniqueness of human beings, and our ability to think, create and invent.

Schlaug's and Patel's experimental evidence offer several leads about the nature of this third way, each of which might give us other ideas about the origins of language and music. For now, answers are yet to emerge from this complex system, as there are still several pieces of the puzzle missing. For one, music and language do not come from an isolated music spot, or language spot.

When the noted neuroscientist Robert J. Zatorre was asked about which part of the brain was concerned with understanding music, he famously responded, "Everything above the neck." We're beginning to discover that music and language are linked intricately in the brain. What we don't know is *how.*

But Mithen believes that the researchers are on the right track. "The fact that the music and language systems in the brain share some modules is also to be expected given the evolutionary history I have proposed, because we know that both originate from a single system," he says. "Conversely, the fact that they also have their own independent modules is a reflection of up to two hundred thousand years of independent evolution."

And on the subject of music's functional importance, he chooses a safe middle ground. "My own view is one that gives equal weight to evolution and culture as regards the manner in which neural networks develop," he says, "All I expect is a broad compatibility between evolutionary history and brain structure – and this is indeed what appears to be present."

Sexy Tunes and Selection

It was June 1967. Californians wore flowers in their long hair and flocked in thousands to the Monterey Pop Festival. Jimi Hendrix was 25, and about to make his first appearance at a rock concert in the United States. He'd just flown in from London, where his wild guitar riffs and psychedelic flavor had made him a musical phenomenon overnight. Here in the United States though, at the Monterey Pop Festival, he had yet to earn a name for himself.

In tight red pants, a yellow ruffled shirt, and an embroidered military jacket, Hendrix took to the stage. In his left hand he held a hand-painted Stratocaster. By his third song, "Like A Rolling Stone," he had won over the crown. But it was the next song, "Wild Thing," that his audience would remember for the rest of their lives.

About two minutes into the song, "Wild Thing," Hendrix turned around, still strumming, and wandered to the back of the stage. Back to the audience, he doused his carefully painted guitar in lighter fluid. Then, as his band continued with the song, he turned knelt on the floor and dropped a match on the instrument. Body swaying to the rhythm of the bass, he watched as his guitar was slowly engulfed in flames. The audience went wild.

Geoffrey Miller, an evolutionary biologist, finds clues to the origins of music here, in musical displays like Hendrix's Monterey Festival performance. He believes that music evolved as a sexually selected trait in human beings – a mating cue, like birdsong, or the feathers of the peacock. Music evolved and stuck around, Miller says, because women liked it.

In 1996, Miller conducted a study on musicians. He mapped their musical careers against their age and found a clear peak in their musical output at the age of 30. "And that," Miller says, "is a signature of sexual selection." Maximizing their musical output in their late twenties, musicians past 30 found wives and settled down to married lives. Their musical productivity, as well as their mating effort declined. Music, he concludes, evolved through sexual selection, serving as a marker for physical fitness and intelligence in human beings.

"Both natural selection and sexual selection boil down to one principle: some genes replicate themselves better than others," Miller explains, "Some do it by helping their bodies survive better, ands some by helping themselves to reproduce better."

Miller's favorite example of sexual selection at play is the legendary Jimi Hendrix. In an article describing his theory, he writes:

> "Consider Jimi Hendrix. This rock guitarist extraordinaire died at the age of 27 in 1970, overdosing on the drugs he used to fire his musical imagination. His music output, three studio albums and hundreds of live concerts, did him no survival favors. But he did have sexual liaisons with hundreds of groupies maintained parallel long-term relationships with at least two women, and fathered at least three children in the United States, German and Sweden. Under ancestral conditions, before birth control, he would have fathered many more. Hendrix's genes for musical talent probably doubled their frequency in a single generation through the power of attracting opposite-sex admirers. As Darwin realized, music's aesthetic and emotional power, far from indicating a transcendental origin, points to a sexual selection origin where too much is never enough. Our ancestral hominid-Hendrix's could never say, "OK, our music's good enough, we can stop now," because they were competing with all the hominid-Eric Claptons, hominid-Jerry Garcias, and hominid-John Lennons. The aesthetic and emotional power of music is exactly what we would expect from sexual selection's arms race to impress minds like ours."

In large-brained animals, sexually selected traits are often disguised as complex psychological adaptations. "Brains are complex, hard to grow, and expensive to maintain," Miller says. With no clear survival benefits, and exhibiting the necessary complexity, music is a prime candidate for a brainy sexually selected adaptation. Miller's case is helped by the fact that functional analogues exist in the animal kingdom. Birdsong, gibbon song and whale song are all examples of adaptations that, like music, have been chosen through the process of sexual selection through mate choice. "Its principle biological function, then, is courtship," Miller concludes.

Sexually selected traits, Miller adds, do not need to "feel sexy." Take beards. "The male human beard," Miller writes, "although almost certainly an outcome of sexual selection through female mate choice, is not a jungle of hidden, illicit motives." Rather, it is simply a biological manifestation of the fact that its wearer is a sexually mature male.

Miller's work echoes Charles Darwin's own hypothesis for music's function and evolution, which he described explicitly in his 1871 book *Descent of Man*. It's a wonder no one has picked up on this theory since then, Miller says.

When Miller first proposed his sexual selection theory of music about a decade ago, he received mixed reviews. "… biologists who studied bird song were very receptive and they thought this makes perfect sense: Birds sing mostly to attract mates, that's well known," Miller says, "It seems to hold along the 6000 species of birds – and to them it was very natural to think of human music has having the same functions as bird song."

Neuroscientists, psychologists, linguists, on the other hand, found Miller's theory unconvincing. "People who studied human music – the music anthropologists, the psychologists who studied music thought it was an outrageous idea, and couldn't possibly be right," Miller says.

Ani Patel, of The Neuroscience Institute, has his doubts. For one, he says, Miller's theory completely ignores female musicians. Sexually selected traits, like beards, or expansive tail feathers, are usually sex-specific anatomical differences. Generations of sand-colored peahens and beardless women are proof. When it comes to music, he points out, we have yet to see evidence that women and men treat or produce music differently.

A deeper problem that Patel sees is that adaptationist theories face the same difficulty that assails every attempt to pin down the origins of so much of human behavior: "Music and language do not fossilize," he says. This makes proving theories like Miller's hard.

Other music researchers also frame objections. "That great musicians have many sex partners seems indubitable," explains Tecumseh Fitch, a music theorist at the University of St Andrews, but "for every Bach with many children there may be a Beethoven who died childless, and for every popular conductor or lead guitarist there may be a lonely oboist or bassist." Patel agrees. "The social patterns adduced by Miller as evidence for sexual selection can be explained by cultural factors such as the importance of music in identity formation in adolescence," he explains, "and male dominance in the control of the recording industry."

While Miller proposes an interesting and intuitively appealing theory for musical origins, the consensus among his peers seems to be that the appeal of music goes much further than that. Ellen Harris, a musicologist and chair of the Department of Music at MIT is appalled by Miller's reductionist interpretation of human musical perception. "What about the sensual quality of music?" she asks.

Jimi Hendrix will remain a legend for his showmanship and his skill with the electric guitar. But is biology responsible for his popularity? According to experts in the field, in this particular case it seems unlikely.

From Ragas to Rachmaninoff

If both evolutionary biology and brain research cannot prove where music did, or did not, come from, where else can researchers look? One place is contemporary music and the similarities and differences that exist in it today. A comparison of the spectrum of human music could potentially shed some light on whether everything from the love ballad to the Chinese opera has a common root, or if lacking universals it indicates that it is a product of culture.

John Blacking, a Canadian ethnomusicologist, was interested in whether a universal human musical understanding actually exists. For fifteen years he lived in the Limpopo region of South Africa and studied the music of the Venda tribal community.

Every year, the young girls in the Venda community participate in a musical coming-of-age ritual. Naked except for a small coverlet tied around their waists, the girls form tight circle, holding each other by the shoulder or by the waist. They chant together and process around the circle in time to their chant. The chants and dance movements follow a very precise progression, and the ceremony spans the length of a few days. Each step symbolizes the stages of womanhood – growth, marriage, and childbirth.

In the Venda community, music is a part of daily life, "an extension of language," Blacking writes. First-hand witness to the "Python Dance," the female coming-of-age ritual, he describes in detail the meaning of the dance's every gesture and movement. But this meaning, he says, was not readily apparent.

"I could never have discovered this if I had not attended scores of performances of Venda, recorded hundreds of word-phrases sung by the soloist, noted the relationships among words, dance, and music, and learned the esoteric symbolism of the school," he says in his book *How Musical is Man?*

"I wanted to become deeply involved in a society, to participate in musical activities over a long period of time," he told an interviewer, years later. "I wanted to learn the Luvenda language, research kinship, political structure, rituals and economic life, just as an anthropologist. I also wanted to study music with far greater intensity than would any anthropologist."

Blacking even learnt the local music. "Above all, it was important to sing Venda children's songs and to participate in Venda drum ensembles," he said. The wealth of immersion in Venda culture and music colored Blacking's perception of their music.

In his book, *How Musical is Man?* Blacking builds on this experience to argue that music is wholly cultural specific, broaching one of the biggest questions facing musicologists and musically inclined anthropologists: how similar or different are the music of different cultures? The ability to make music is inherent in human beings, he concludes, but to understand it, a cultural context is necessary.

"I had to immerse myself in Venda culture and society," he says, "in order to understand this product of the Venda minds."

All known cultures create music in some form. But according to Blacking, the differences between musical traditions dominate: understanding the music of a culture different from one's own requires a degree of immersion and study. Music and culture are inextricably linked, he claimed – you cannot understand one without the other.

Ellen Harris agrees. A professional soprano, and musicologist trained at the University of Chicago, she is now chair of the Department of Music at the Massachusetts Institute of Technology. She believes music and the messages it conveys are culturally based.

"Our harmonic system in the West… is something that is ingrained in the West even if you're not studying music, because it's in nursery rhymes, in popular music," she says, "It's this kind of patterning that says *this* chord leads to *this* chord."

Harris teaches classes in song and music to the undergraduates at MIT. She's tested her hypothesis on her classes through the years: "So if I sing, '*Twinkle, twinkle, little star/How I wonder what you are/Up above the clouds so high/Like a diamond in the sky…*' and then say to the class, 'Could it end there?' And by and large they laugh and say, 'Of course not – that's not an ending note. It doesn't feel *finished*.'"

Harris says the foundations of Western classical music are based on the same feeling of having "finished," by a build-up and release of harmonic tension.

"So if you don't hear that kind of structure – if you don't hear one note *needing* to go to the next note – how you can figure out a Beethoven symphony is beyond me," she says.

That question – is Beethoven really out of reach of non-Western cultures – served as a challenge to Tom Fritz, a cognitive psychologist. Now a researcher at the Max Planck Institute for Human Cognitive and Brain Sciences in Leipzig, Germany, he set out to test whether there may be some connections between musical affect and human emotion that might transcend cultures.

To find out, Fritz, like Blacking, sought out an isolated tribe, this time in Cameroon. But unlike Blacking, he found evidence for universals in musical expression – *biological* responses that transcended cultural shaping of musical styles.

In this, Fritz was picking up on a recent thread of research. The first clues that mapped emotional responses to music came from a brain imaging study from Canada in 1999. A group of researchers at McGill University located areas in the brain that were tickled by emotionally suggestive musical cues. That investigation identified some of the brain areas that were activated when their subject said they were saddened, or cheered up by certain musical cues. For Fritz a question emerged from these results: what was it about these musical cues that activated the specific emotional centers? A simple musicological analysis of the pieces drew Fritz's team to the pattern of dissonances and consonances that were arranged through the pieces.

If you play the last two notes of a major scale together, they would produce a discordant sound, which most people would call "unpleasant." This "tonal tension" caused by the two notes is called dissonance. A C major chord, on the other hand, is an example of consonance. Here, the interval between the notes being played is such that they seem to fit together. Two notes, an octave apart, when played together are consonant. If they're a half step apart, they are dissonant.

Dissonance and consonance has been defined on the basis of the mathematical relationship between competing notes in the final tone. What Fritz and his colleagues didn't know was if the powerful, often emotional effect they had on their listener – one of comfort or unease – was biological, or culturally tempered.

Fritz's first breakthrough with the emotional hold of consonance and dissonance came in 2006. His team picked a random group of ten right-handed Germans who were familiar with the Western musical tradition. None of them had been trained to sing or play an instrument. Fritz played the ten people a set of classical musical pieces, which were musicologically associated with a "pleasant" listening experience. He played it a few times, so they became familiar with the pieces. Then, as they listened, he imaged their brains. On a piece of paper, they rated the music on a scale from -2 (unpleasant) to 0 (neutral) to 2 (pleasant).

The imaging results showed the emotion processing areas of the brain, the limbic and paralimbic systems, lighting up in response to consonant and dissonant musical cues. Musical stimuli, Fritz had found, were powerful enough to activate the same brain regions that corresponded to emotionally charged events in a person's life.

Was this biology talking? Or had cultural conditioning trained the brain to respond in particular ways to patterns of dissonance and consonance? Fritz's next step was to attempt this experiment with non-musicians who had not encountered Western musical influences: a group of people who had been completely isolated from Western culture.

"It's very hard to find groups of people like that in the world today," says Josh McDermott, a cognitive psychologist who studies evolution of music at the Center for Neuroscience at NYU. A friend of Fritz's, he was particularly interested in the outcome of the study, with its attempt to seek out expressive elements in music that transcend culture, and could be part of the original proto-music, before cultural diversification took place. Fritz found the Mafa people, packed his bags, and flew to Cameroon.

Fritz noted that the Mafa worked music into their lives in a way that differed from most of the Western world. (Twenty years earlier, Blacking had described the Venda musical tradition in a similar way.) "They don't have a word for music," Fritz says of the Mafa tribe, "The reason for this is that music is a really integral part of rituals. So, daily rituals like sowing seeds or working on the fields or washing clothes, or long term rituals like dealing with the dead."

Given this difference, would the Mafa still pick up on emotional cues that were programmed into Western music? Were elements of Western music that gave songs a "sad" or "happy" quality culturally rooted? Or were emotional associations with certain musical chords, or scales, biological?

Over his three months in Cameroon, Fritz played the Mafa a mix of music from around the world – instrumental music from the past four centuries. "So, Irish jigs, and jazz, and tango music, and some, you know, typical classical music like Bach, or Dvorak – just a great variety of musical sounds – all instrument music," he says.

Fritz handed his experimental subjects sheets of paper that showed a range of facial expressions, from a smile to a frown, over a series. To the Mafa, this experience quite foreign. "Most of them had never seen a pair of headphones before," says Fritz. Practicing music almost entirely in the context of ritual or ceremony, they were not used to listening and responding to music played for its own sake.

Then Fritz returned to Germany, and repeated his experiments with German listeners who had grown up listening to Western music. To them, minor scales immediately represented a sad moment, while a happy emotion was expressed by a major scale.

The results were surprising. In spite of the vast cultural difference between Fritz's Mafa and German listeners, their reactions to the music were comparable. On the emotion matching game, Mafa listeners mostly agreed with their German counterparts, who had grown up listening to music Europe. Mafa listeners were also able to tell, above chance, which pieces were meant to be scary or fearful.

To put Fritz's results another way: a Rachmaninoff aficionado may not be able to interpret the delicate frills of an Indian raga, but there may be some switches that the musical constructions throw in one's brain regardless of what musical tradition one grew up in. His observation that three basic emotions – happiness, sadness and fear – were universally expressed and interpreted seems to support theories that suggest that music was a communication tool for emotion.

Why would this have been useful? Steven Brown, of the NeuroArts Lab believes that music arose to communicate emotional messages, to cement the supportive environment of a group of people. Traces of this origin, he says, are manifest even today as group cheers at football games, or chanting and singing sessions at religious gatherings. In this view, the concept of an ancient musilanguage returns: originating as a single combined faculty, human communication forked into two. Language allowed humans to communicate with other human one-on-one. Music, with its universal emotional hold, was the cohesive glue that held quickly swelling human groups together.

How musical differences between cultures came about is up to speculation. Perhaps as groups faced one another, or warred, they evolved their own signature musical calls. If this was the case, it seems that musical signatures of today retain some evidence of their common birth, while the differences are really superficial. Fritz's new work suggests that no matter where you grew up, dissonance means danger, and consonance means safety.

Music: Cultural Glue

"There's nothing quite as thrilling as standing in the back row of a theater, and seeing all 150 people in the pit and on stage … and 2800 people in the audience all having this communal experience," says Daron Hagen, " … and your music happens to be a central motivating, enabling factor in this communal experience."

Hagen is not yet 50. He lives in New York City, drives a fast car, and composes for big opera companies. He wrote his first opera when he was eleven, went on to study composition at Julliard and later trained under Leonard Bernstein. After spending the past 40 years of his life immersed in music, he finds that the most rewarding part of creating music for a composer comes after it is complete

"Composing music," he says, "at its most sophisticated level, is *so* profoundly eloquent that dictators ban it, that they're actually frightened of it."

It's not just opera. Most people can remember the first time, or the last time, they were particularly moved by a certain melody, a particularly elegant guitar riff, or a beat that got their feet tapping. Certain tunes and chords, "sad" music, has the same effect on the brain as the loss of a friend, or the death of someone close. Happy music tickles pleasure areas in the brain like good food, or sex. People produce music to celebrate very important, very emotional events, like religious ceremonies, weddings, funerals, birthdays.

And music has been doing this for thousands of years, its appeal transcending cultural boundaries. Though Venda tribal initiation rites may appear dramatically different from the Habanera in *Carmen,* theories presented here hint at deeper, more substantial roots. Evidence of this ancient common history is seen in emotional responses that music draws out in its listeners that is non-culture specific, and echoes of musical behavior in non-human species.

Because music is so abstract, none of this can be proved. But, whether music was selected by biology, hardwired into our DNA and descended from a primate ancestor, or a product of a culturally savvy social brain, there is no doubt that it brings people together. In the African Savannah two million years ago, or at the Metropolitan Opera House on a Saturday evening in 2010, it is a medium in which human beings immerse themselves, and form bonds, links, and memories.

As an expression of individuality, or a proclamation of group identity, it has stuck to human nature like glue, and become a part of our identity.

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