>> From the Library of Congress in Washington, D.C.

>> Hi, this is Steve Mencher for the Library of Congress and we're continuing our podcasts connected with the music and the brain lectures here at the library. I'm speaking with Ani Patel, who's the Esther J. Burnham Senior Fellow at the Neurosciences Institute in San Diego, California, and we're talking before his talk on the music of language and the language of music and we'll certainly talk later about how this is meant to be taken both sort of literally and figuratively. But first, tell me a little bit about yourself and your background and your interest in music. Are you someone who started in studying music as a kid, did you take some kind of lessons.

>> Yes. I took music lessons. I was lucky enough to go to school at a time when you could take music lessons as part of school. So I started in elementary school, on the clarinet, in group lessons and played in the band and then, in high school. In the high school orchestra and then college picked up guitar and taught myself. And then went on to study classical guitar in graduate school. So, yea. I've had a life-long love of music as a amateur. Never studied it for a degree. All my degrees are in biology. I'm a scientist and I came to music through a love of both biology and music and trying to find a way to put those things together.

>> Great. Now let's dive into one aspect of this right away because I'm interested in this. Do you think, or have you learned, or do your colleagues believe that because you studied music as a youngster your brain is somehow different than people who didn't study music as youngsters.

>> That's actually a hot topic in the study of music and the brain, as to what extent does learning a musical instrument actually change the structural and functional properties of the brain and I have colleagues that work exactly on that question. There's a lot of work being done in Boston by a colleague named Gottfried Schlaug. A neurologist and musician. Who has been studying kids. His studies are particularly interesting because there's been this persistent question of, are people who are musical that way because their born with something special, something different, and perhaps some are. But, he's done some studies where he's actually started structural imaging. Looking at the brain structures of children. When they set out to begin learning music. So very young 5, or 6, or 7 years old, and tracks them while they learn music and it's showing that, kids who do and don't start music lessons. There are no real obvious differences in their brains to begin with, but as they learn instruments, and as they progress you begin to see structural differences in the brain. This is what we call experienced dependent plasticity in the world of neuroscience. This is that the brain is an organ that changes with experience, the very structure of the brain changes with experience and you can see that using modern imaging tools, and music is a wonderful tool for studying that because it involves many hours of practice, it's very rewarding, people engage in it for a lot of time and a lot of emotional commitment. It's a very natural kind of experience that you can study in terms of its effect on the brain.

>> That's fascinating, and we'll get probably more into that sort of thing as we continue talking.

>> Sure.

>> I love some of the other questions that you and your colleagues are investigating and again this may not be right down the center of what you're doing, but one question I saw that you were interested in was looking at how music might give us chills. [Laughter] Oh. How would we find out about that?

>> Well, it just empirically does, I mean, so in an early study of chills to different kinds of art. I think it was a paper by Goldstein, showed that music more than any other kind of art, reported as evoking chills to listeners more than visual art or movies, or theater. Although those also did too and people differ in the music that gives them chills. So, in fact that was the basis for a very creative study by a couple of colleagues in Montreal who did brain imaging of people listening to music that gave them chills. So they brought in their CDs of their own self selected music, listened to it, got chills while they were having their brains imaged and, that was confirmed by very physiological measures that were being taken and then they looked at the brains to see. And now even though everybody's music was different, in terms of what gave them chills, some of the brain responses were similar, some of these areas that we know as neuroscientists are associated with a kind of reward, sending reward signals to the brain, typically for biologically important behaviors such as reproduction or food and so forth were actually being activated by hearing purely instrumental music. This highly abstract stimulus was jolting the brain in a way that was surprisingly powerful given that these centers were thought to be, you know, ancient evolutionary centers for biologically important kind of behaviors.

>> Huh, that's fascinating. I know I've done some interviews with people who write music for the movies and their very, they know what notes to play, and how to arrange them on the page and what instruments he has in order to make those chills happen.

>> Yea, I think movie music is applied music cognition. I mean this is really trying to get a particualr response out of a listener.

>> Uh huh, now, could you sort of help us to, to figure out what is driving some of the research on music and the brain. It seems like we're recognizing an explosion in this.

>> Yes.

>> And I wanted to ask you, as one of the premiere researchers in this area. Why are people looking at this?

>> I think people are coming to music for a variety of reasons as neuroscientists. Some of them are interested in the emotions, and the music is a particularly powerful way to elicit emotions, particularly positive emotions. It's quite practically, if you put someone in an FMRI scanner and your interested in studying---

>> I'm sorry what's an FMRI?

>> Oh, I'm sorry FMRI. Let me explain that. Functional magnetic resonance imaging. It's the, you know MRIs . Most people are familiar with those. That's a technique that gives you pictures of the structure of the brain and if you tweak that technique you can actually get pictures of activity in the brain. Regions of the brain that are more active as you hear things, or do things. And there's been a fair amount of work on emotion in using that technique, but it's focused largely on fear, on negative emotions and part of that is practical, I mean how do you get somebody to feel really great when they've got their head stuck in a metal tube and gigantic noises being pounded at their ears, you know their claustrophobic, their you know. It's not a pleasant experience and yet if you use music that they like, you can actually have people have extremely positive emotional experiences, lying in this highly artificial environment. So just practically, it gives you a way to study interesting things about the brain that you might have difficulty getting in other respects. Aside from that, I think this issue that we just mentioned before, plasticity, how does the brain change with experience. We're recognizing that music is a wonderful tool for exploring that. In my own interests in the relationship between music and language we're learning that music has enough similarities with language, that you can actually use them together to get some deeper insights into the underlying mechanisms in both domains. So, I think people are coming to music as neuroscientists for a variety of reasons, and what's neat is that there seems to be sort of gelling to this community, of people that really are interested in this subject, and have nice dialogues, have conversations with each other and can promote each other's interests in work.

>> That's fabulous. Now do you all get together at conferences or are there, is there a group of you that meets regularly to discuss these kinds of things.

>> Yes, luckily. In the past few years there's been a series of conferences called the neurosciences and music. The first one was in New York City at the New York Academy of Sciences in 2000 and there have been three more sponsored by an Italian foundation called the Mariani Foundation, who's taken a real interest in this field and it's really helped the field by bringing us together every year or two to discuss these issues to talk about our latest research and stimulate each other's ideas.

>> Let's zero in now one of the particular areas of research that your looking at, and that's music and language. Why did you get started on this area of investigation?

>> Well, I was interested in how the brain processed music but when I started studying this back in the mid 90s we had much less information than we have today. I think it's really exploded just in the past decade. And so I thought well, the biology of music is a little far out but people think the biology of language is a reasonable subject, there's lots of work in that domain and language and music have some obvious similarities. There, they both use structured sound sequences, they

involve learning, they involve kind of processing of emotion and structure, and they have a lot of arrhythmic aspects in common. So why not study some of the biology and neurobiology of language as a way to learn some concepts and I have some techniques that I can apply to the study of music. But in the process of reading, learning and studying I began to see more and more interesting connections between these two domains, and I thought, well hey let's, this is an interesting subject in and of itself. Just to what extent are music and language drawing on similar brain mechanisms versus separate brain mechanisms and how can we use them in comparison to learn about those mechanisms, what they are and how they work.

>> That's great. Now, you'd have to assume in a sense, in order to do this work, in order to be devoted to it, is that music was as important to us as humans as language or at least as central to our experience, and not everybody would buy that argument off hand.

>> I think that's true. You have to believe that music is an important part of our human kind of toolkit, I mean that anthropological evidence certainly points to that, it's something that's found in every single human culture, like language, it goes way back in our species, past is like language, The oldest instruments that we know of are Paleolithic flutes that date back to about 40,000 years ago, so it does seem to be something that has been part of human communities for a long time and universal. Now your absolutely right, not every single human individual engages with music to the same degree, and some actually try to avoid it. In, fact there are, there's actually a fair amount of work in my field now on people that are so called musically tone deaf, which some use to think was a myth which is turning out to be real. It's different from what people conventionally mean by tone deafness. A lot of people self label as tone deaf. Generally they don't sing well, they don't like their own signing voice. That's not what tone deafness is. True musical tone deafness is a problem with perceiving music, its basic problems, like you can't tell when two melodies are the same or different. You can't recognize what should be highly familar tunes from your culture unless they have words with them. You can't tell when music is out of tune, including your own singing. And so there's now actually a battery of tests that's used to diagnose true tone deafness, and it's turning out it has genetic and neurological underpinnings.

>> Now your bringing us around to the interesting, well not the interesting, but one of the key parts of your work, if music is central to who we are and what we do and if there are people who can't process music, than you can make an analogy when people are having trouble with language and they can no longer process language because of brain damage or some other issues.

>> Right.

>> Then studying the two things in conjunction could really get you alot further than you would have by studying one or the other.

>> I think that's a key insight, and you know as a biologist one of the strategies we have for understanding living systems is to compare them to

other things, and, so if we want to understand the digestive system. We look at, not just humans, but other organisms to see what the range of possibilities is, and there's a lot in common in the digestive physiology of a human and other primates say. But language and music are kind of a lonely phenomenon, and from a comparative prospective. We don't know of any other species that has anything quite like language or quite like human music. And so as a biologist it makes it difficult to use that comparative strategy. But realizing that they have enough in common that you can compare and contrast them to each other gives you a little bit of that comparative power back. By looking just within the brains of humans and comparing these systems to get inside at the underlying mechanisms.

>> Ok so what, by studying music, and by studying language, and by looking at the two things, how can you begin to make solutions, say for people who have lost the ability to use language.

>> One thing we can do is we can study what are typically considered language disorders to see if they really are purely language disorders or if they involve problems with processing music as well. And we've done some of that work, looking at a common disorder known as aphasia, which is acquired language deficit after brain damage and there's a particular type of aphasia, that involves problems with grammar and syntax and understanding the structures of sentences, and we've done some work with those patients to see if they also have some problems understanding the structure of musical sequences and it looks like they do. And this is actually very interesting, because it suggests that whatever's wrong at the mechanistic level is not some very specific language operation it's something about processing structure and time and hierarchical sequences, and that perhaps the way we should think about treating it, is not just by doing language but maybe other types of mental exercises, including musical ones perhaps, help us regain our some of the structuring processes capabilities.

>> in listening to some of your earlier lectures and in looking at your work, it seems that the digging into music, and breaking it down into its parts, and then looking at what happens in the brain is one of the things that fascinated me. In other words, if you're looking at rhythm, if you're looking at pitch if your you're looking at all the different parts of music, and what music does, and what music is, then you can begin to look at the way the brain works on all these things differently and similarly. Can you tell me a little bit about that part of your work?

>> Well, yes, I think that's the key insight that music is not one thing, its many processes that interact. There's the processing of rhythm, the processing of pitch, of tambour, there's the emotional processing and all these have different basis in the brain, and looking at how they interact is part of what's so interesting. So just take one example we're very interested in rhythm and the relationship between the auditory and the motor system in music. Now one thing you see all over the world, in every culture is people moving to music and synchronizing to music, and to the beat of music, this is universal and starts early in life and it continues on through life and is the basis for dance and so forth. And it's kind of a remarkable response if you think about it. Here is this sound that is making you move your body arhythmically, not literally in

attempt to make sound yourself but just in response to the music. You don't see that in any other species, until recently, actually, we've done a little bit of work now, the cockatoo seems to dance and synchronize to music. But this is telling us that there's something in our brain, that connects the auditory system to the motor system in a very tight way, and understanding that is really worthwhile. Not only for the basic neuroscience of understanding how different brain systems work, are coupled in perception and behavior, but for the practical reason that music therapists to observe that Parkinson's patients can sometimes, those who are kind of frozen motorically can sometimes initiate movement, and coordinate movement and keep things going, like walking when they hear music with a beat versus when they don't. And it would be wonderful to understand how that works and sort of optimize the therapy that would help them with their movement disorders.

>> You know the fascinating thing when I heard speak about this before is that you might think, well it's the music sort of causing the movement in some way or another, and then when I guess you study the videotapes and listen to the music and so forth if the movement is anticipating the music a little bit than it can't be the music is somehow causing movement. You would think the, it's a lot more complicated than that. When you move to a musical beat you typically let's say your tapping with a metronome you find people are very good at that, anticipate the metronome a little bit, it's not that their, it's not click, react, click react, click react, it's very in your moving in accordance to a model of time that you have that's influenced by the metronome that's in your head. And that's very interesting, yea.

>> Can you tell us about some of the things perhaps that you won't talk to us in your lecture today, but some of the areas that are a little further out, some the things you say if, when I get the time, when I get the money, when I get the bigger lab and the ten more assistants, this is what I really want to look at.

>> Oh, interesting. We are doing sort of basic research on moving to music, some of the brain mechanisms that are involved in motor systems, but if I had the resources I would actually love to work with patients and actually see firsthand about how music helps Parkinson's patients. You know Oliver Sacks has written about this in his book Musicophilia, I've heard about it through colleagues, but I've never seen it firsthand. And I think seeing it first hand and actually having a chance to work with neurosurgeons who treat Parkinson's disease through different kinds of brain stimulation and coordinate therapy with them based on rhythmic music and stimulation would be really fascinating project with combined basic neuroscience and combined benefits for people. That would be wonderful. That would be the way to go in the future.

>> Just as a final question when you're listening to music when you're just enjoying music, when you're playing music or when your sharing music with friends or family does your research kind of pop into your head, are you kind of looking over yourself music kind of pop into your head, and wondering what your brain is doing, and the chemicals and everything else is doing, or can you let all of that go and just kind of enjoy music in the way you did maybe when you were kid.

>> I enjoy it very much at an intuitive level. When I'm experiencing music in an artistic context as opposed to a scientific context and I think the idea that studying something scientifically ruins ones appreciation for it, you know whereas we murder to dissect is a little oversimplified. Mean if you really talk to musicians and scientists who study music, most of them are music lovers, they have an intuitive love of music. and if anything their science enriches their music, it doesn't diminish it. And it's like a phlebotomist if you know every name of every part of every part of a plant; does that mean you can't see beauty in flowers anymore? No. I mean these are sort of two different levels of appreciation. There's a nice actual lecture on Youtube by Richard Fineman who answers exactly this question about physics and is arguing actually knowing the physics only enhances his appreciation of aesthetically meaningful beautiful phenomenon.

>> So none of this gets in your way when you listen to music and enjoy?

>> Not yet. I really hope not because otherwise it would ruin my whole reason for getting into this field.

>> Well thank you very much Ani Patel of the neurosciences institute in San Diego, California, I'm Steve Mencher for the Library of Congress.

>> Thank you Steve.

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