>> This is another one in our series of Music and the Brain podcasts. I'm Steve Mencher, and I'm here with Dr. Gottfried Schlaug, Director of the Music, Neuroimaging and Stroke Recovery Laboratories at Beth Israel Deaconess Medical Center and Harvard Medical School. Welcome.

>> Thank you.

>> You've just given a talk today here at the Library of Congress, and we'll get into the subject of your talk and some of the meat of it, but first I'd like to hear a little bit about you. I've been told that you're an organist. What kind of music do you play and where do you play it?

>> Well, if you're an organist, then probably your main composer is Johann Sebastian Bach, who has written a voluminous work of organ, and basically every organist is challenged by playing this work, so I really love and like playing Bach's work, but I'm also very interested in the French romantic period, so I play Cesar Franck and Charles Widor and Vierne and Marcel Dupre and various others. But unfortunately, I can't practice as much anymore as I would love to. Most of the practice -- actually in the hospital that I worked there is a chapel that has an organ in there where I can practice every now and then. And then I belong to a congregation burst [phonetic] that has an organ so I can play there, too.

>> Wow, that's fabulous. So, when did you start playing the organ?

>> Well, I actually took quite a detour to get to organ. I started playing recorder when I was six, and then we had an harmonium at home, which is actually an instrument where you [inaudible] have to pump the air yourself to get a sound out of the pipes. So I went from recorder to harmonium. And when I was about nine years old or so, I think we got an organ, actually my father built an electronic organ that we then were able to practice on. And when I was about 12 or so I actually had a job in a church playing very regular services on a Sunday morning. So, that's how my transition has been, from recorder over harmonium to organ.

>> Wow. That is fascinating to me. And is the playing of music and the love of music, is that what got you started in being interested in how music works in the brain? Or did you come at it from more of a medical point of view first? Or -- tell me about that.

>> I always wanted to be a musician when I grew up, and that got changed a little bit when I really had to make a decision what I was going to do in life and what I would enjoy most. And I had, after I graduated from high school, I had to do some social work because I was a conscientious objector, and during this period of time, I decided that I was -- that I got more joy and pleasure out of working with people and helping the ones that would need help and so I decide that medical school was the right thing for me. But the first few years, I went through lot of struggles, whether or not that was really right, and I missed music, and it was difficult to really combine music with going to medical school. But, nevertheless, I persisted in getting a medical degree. And it really then occurred only after this, in basically in the early '90s, when finally imaging was good enough to actually take a look into other people's

brain, and the imaging itself wasn't really dangerous and radioactive in a way. So, really with the advent of what we call magnetic resonance imaging, I got this idea that, you know, my background has really been in music and in musicians, and now I have all this great exposure to neurology, to neuroscience and to this great tools. I could potentially combine these two fields, and that's how it all started.

>> Wow. Now, the first time you peered into somebody's brain, and with trying to figure out whether a musician's brain was going to be different from a non-musician's brain, how -- what's the beginning part of the thought process and the experimental process of trying to look at those two different things and trying to get some results that will stand up scientifically?

>> So, we started out actually with an hypothesis that is -- coincidentally was actually developed at the institution where I work now at the Beth Israel Deaconess Medical Center in Boston. In the '80s, there were two researchers: Norman Geschwind, who is truly the father of behavioral neurology in the United States, and Albert Galaburda, who came up with this hypothesis that music might potentially be in the right side of the brain, or that the way that [inaudible] hypothesis was more like this: both sides of the brain are not created equal, there is actually a symmetry in the brain, and one marker of the asymmetry sits in the brain region that analyses sounds, so the temporal lobe. And this marker is called the planum temporale. It turns out that in right-handers, it is larger on the left side of the brain than on the right side of the brain. So it has been used as a measure or marker of hand dominance, but it has also been used as a measure or marker of language lateralization because it is larger on the left side of the brain, and typically most language functions are on the left side of the brain.

>> I'm still not following what language lateralization would be. What would that be?

>> Well, that one part, or one region or one hemisphere of the brain is more dominant or more engaged in language processing than the other side of the brain. That's what laterality means. So Geschwind and Galaburda came up with this hypothesis, that if there would be people that deviate from this typical pattern of brain laterality, meaning if they have either a symmetric brain or a right-sided asymmetric brain, then they might be particularly talented in what at that part -- at that time people thought on the right side would actually be do -- doing, which would be music and music processing. So, they hypothesized that individuals that have a symmetrically organized brain or a right-sided dominant brain, that they would be particularly gifted in music and in musical skill. So, that was actually the hypothesis that we had when we, for the first time actually ever, put professional musicians into an MRI scanner in the early '90s. Now, it turned out that that hypothesis was actually wrong, because we were not able to prove this, that musicians were either more symmetrically or right-sided dominant. They actually were similarly left-sided dominant than non-musician controls. But, surprisingly, was -- or very surprising for us was that we found a group of musicians that were very asymmetric towards the left side, and this group, or this subgroup of musicians were musicians who had absolute

pitch. Absolute pitch is the ability to identify or name a musical tone in the absence of any kind of reference tone. That's actually not necessarily the naming, the naming is a secondary phenomenon, basically, a learned association. It's really the perception is different, that one perceives tones as belonging to certain pitch classes. So, it turned out that this subgroup of absolute pitch musicians that we had in our assemble of professional musicians, they were extremely lateralized towards the left side, and they were actually dragging the entire group to more towards the left, so making them very left-sided dominant. That was our very first study. On one hand, we were not able to actually substantiate this hypothesis that had been put forward, and on the other hand, we actually found something that was quite surprising. We basically found a brain correlate of absolute pitch.

>> As you stated to look more deeply into the brains of musicians, from what I understand, you did start to see some things that were different, even in those who didn't have the absolute pitch, and you started to be able to identify parts of the brain that might be, I don't know, is it bigger or smaller or different? What did you start to see?

>> After these first studies, we obviously then spent a little bit more time in developing our hypotheses, and we thought that a musician is basically an auditory motor athlete: they train the auditory system by making better discriminations between sounds, and they train the motor system by being able to make or do fine motor skills with both hands, either concurrently or independently. So, we developed, you know, more regional hypotheses in the brain to look into these particular systems and to also look into connections within the systems. And across various studies now, I think we have found that the motor system develops more, and the auditory system develops more, and again, the connection between both of these systems develop more, and also the connection between the right side and the left side develops more in musicians that practice a certain amount.

>> Okay. Now, my understanding, again, from reading some of the material was that, as you looked and started to discover these connections, there were a sort of a ripple effect. And there were a number of connections that were kind of like music practice. So the fine motor skills might then be translated into ability to do other fine motor things. And then there were things where a leap had to be made, and this is what people were clamoring to get the answers for, at exactly in the '90s. Did music help with, you know, helping with language, helping with math skills, helping with other educational skills? So, how did your experiments go on a similar kind of ripple effect as you looked for the close and the further kind of results of the musicians and the musical study?

>> Yeah. So, one of the first glimpses that we got at this was that, we found differences in regions of the brain that seemed to be doing like more higher order functions, that seemed to be integrating information, both on the auditory and the motor domain, or from the auditory to visual and the motor domain, and then also seemed to be engaged in an output system that seemed to be more sophisticated, more complicated, so like more at the front end of the actual execution. So, one of those regions, for example, is in what we call the inferior frontal gyrus. It is a

region in the brain that sits in front of the motor system that has rich connections, both with the auditory system and the motor system. So, this region was different as well when we compared adult musicians with adult non-musicians. And there was all this knowledge about this region already, and one of the hypotheses, for example, that we have now is that music might potentially change, or music-making might change the structure and function of these multimodal integration regions in the brain, and that if I then take a test or a task that is not musical in nature, that might be a completely different test or task, and if that particular test relies on this region as well that has been changed by music-making, that that might then influence, and we hope positively influence, actually, the performance of this particular task.

>> Good. So let me ask a little bit about the implications of your research for certain groups: let's say young people, for instance. Are you starting to develop, perhaps, recommendations that musical education, that instrumental practice and introduction to instruments is good for young people?

>> Yes. My own experience has been that that is good, and I see this in my kids as well, and I would obviously like to have everybody to have this kind of experiences that I see musical children have. Practically, obviously that is not always easy to do. And certainly in periods where there is stress on funding and where schools have to cut back, usually the first subjects that are cut back is actually arts education. There's also one other issue that frequently arts education over the last years has been defined as, you know, what kind of benefits it might actually have, what secondary benefits it might have. But, you know, making music and engaging in visual arts also has its intrinsic value that I think we should never forget. Nevertheless, I also feel that we can obviously use that, you know, to our advantage, that it might potentially have extra musical or extra arts effects. I'm a strong advocate of having more arts and certainly having more music and more actually music-making in school than we're having right now. There are some people who have come to the conclusion that music making might be just another form of schooling or even more schooling because the result of their research might indicate that all that music actually does, it just leads to a general increase in cognition. But my feeling is more that, even if that would be true, kids might still have more enjoyment with actually getting that additional hour of music instead of getting an additional hour of something else. But we also feel that there is evidence out there that music might actually lead to specific enhancements or particular enhancements in particular domains and not just a general effect. There might be a general effect, too, but there are certainly specific effects. Taken altogether, I think there is enough data out there that would support a strong role of arts in general and certainly music-making in our education system.

>> What about the possibility that music might be able to help people whose brains are in some ways damaged or where connections are not being made in the brain? Do you have any research that backs that up?

>> Yes. So we actually have been particularly interested in this, and part of this has to do with the fact that I'm a medical doctor. I'm a

neurologist. So, our first study was actually using a form of music-making, which is a form of singing, to help patients that have suffered a stroke to regain some of their language functions. And our second study is to use like a similar approach to see if we can use forms of music-making and forms of singing to help children that have not developed any verbal skills, to help them develop verbal skills, and also to help them become more interactive either with their environment or with their therapist or other partners in their environment.

>> Okay, and just tell me briefly, you know, you said you had two children. What kind of a musical education are you giving them right now?

>> It was actually very difficult for us to pick a musical instrument for our own children, because we were concerned that we would pick the wrong instrument for them, obviously, and so we took them to musical schools and they played various instruments and actually the older one --

>> How old is he?

>> She is --

>> She, I'm sorry.

>> She is eight years now, and she was about four or so when she started. So, she actually decided that she wanted to play cello, and cello is actually a really nice instrument. It fits, like, well with your body and it makes a very warm, pleasant sound. And it's a great instrument for kids to learn. And she's very happy with this and she's excelled nicely. The one that followed after her was two years younger, and so we had a lot of concerns of, "What instrument do we pick now?" And it turned out that she also liked cello. So, now we had to discuss, you know, among us and with the teacher, you know, what kind of conflicts we would be creating by having two cellists in the family; but so far, it has actually worked out okay. I mean, they both enjoy playing their instruments. There's not really a competition between them. There's a two-year difference, so they're playing at different levels but they are both enjoying the instrument. And it has been actually for me really an experiment that I basically do at home by having these musical children and seeing them actually excelling on their instrument. So, it's a great pleasure to actually see this happening in my own house.

>> Well, I want to thank you, Dr. Gottfried Schlaug, Director of the Music, Neuroimaging and Stroke Recovery Laboratories at Beth Israel Deaconess Medical Center in Boston and Harvard Medical School. Thank you very much.

>> Thank you for having me.

>> I'm Steve Mencher, and this has been another one in our series of Music And The Brain podcasts from the Library of Congress. Thanks for joining us.