What Makes Music So Significant?

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JEANNE BAMBERGER: We teach kids how to read music, which captures features that are very different from what we're paying attention to when we listen.

ROBERT FREEMAN: What we don't need is more professional musicians, what we need is a whole army of avocational musicians, of people who take great pleasure in being involved in music from an early age, it's truly one of God's great gifts to humanity.

SHOW OPEN

ROBERT FREEMAN: I grew up with music all over the house and I had the music, a music teacher, or a would be music teacher, trying to share with other kinds of people whether high school or college students or adults or children, the huge excitement that I have always gotten out of music, what I don't know is whether that's part of my genetic background, part of the fact that it's the first language I really learned, and how best to teach that to other human beings.

MARK TRAMO: And then I would argue that music in the form song predated our ability to speak. We were communicating emotions and ideas with grunts and groans and chants and hums well before we were enunciating complex ideas like the ones we are supposed to be sharing right now. So I think that there's a real root to it that we find very compelling.

JEANNE BAMBERGER: Out of the grunts and groans has grown the complexity of the music that's been created since then because it embodies a lot of the organizing principles that we find in almost every other domain.

ROBERT KUHN: What are some examples of that?

JEANNE BAMBERGER: Symmetry. Periodicity.

MARK TRAMO: And that symmetry I think relates to a large part our natural affinity for music, the degree to which children, for example naturally gravitate to music. It seems that as humans we have a compulsion to order, organize, control the environment around us. And music relates to our acoustic environment, we're surrounded routinely by a cacophony of sounds coming from all over, and here we take all of those sounds and organize them with respect to their frequencies, with respect to when those combinations of frequencies are occurring in time, with this beautiful regularity, beautiful structure, and that's of great interest naturally to us to experience sound.

What Makes Music So Significant?

JEANNE BAMBERGER: On the basis of the research that I've done, it turns out that what everybody knows how to do by the time they're 5 or 6 in this culture, they know how to hear beginnings and endings and they know how to hear what is usually called functions, that is, they can hear that PLAYS PIANO (INSERT LASSIE SONG) they can hear that that doesn't sound like an ending PLAYS PIANO Now that sounds ended, and furthermore I've seen a little girl listening to a performance of *The Magic Flute,* three years old sitting on the floor, she got bored, she stood up and she began walking, and she walked one direction and at the ends of the phrases she turned around and walked in the other direction, okay, and she kept that up for the whole tune. So what people can hear are beginnings and endings, and they can hear finished and unfinished, stability and instability, so one of the problems is that we start beginning music education, with notes.

ROBERT FREEMAN: We teach kids how to read music.

JEANNE BAMBERGER: We teach kids how to read music, which captures features that are very different from what we're paying attention to when we listen.

ROBERT FREEMAN: Of course, I don't know what you hear when you hear music and you don't know what I hear.

JEANNE BAMBERGER: No I don't, that's right. But I tried to find that out by asking kids to invent ways of putting down on paper something they had clapped, for example. And what they capture is different in very specific ways from what's captured in the standard notation. But it's also very much inherent in what we're, so when people hear our gesture, or movement from, from/to, that kind of thing, but they don't measure, which is exactly what the notation captures, they don't measure, they don't measure either time, nor pitch and furthermore, they glob together as an early notation. Early notation with squiggles that showed a whole little figure, and that's exactly what kids do.

ROBERT KUHN: What are some examples of that?

JEANNE BAMBERGER: Well you could take gears. We have kids playing with, with great big cardboard gears that they had made of different numbers of teeth and the question was, when you turned them around, which one went faster? Well, and one little girl said, "well it depends on what kind of fastness you mean. Because if you're talking about the number of times around, then the little one's going faster. But if you're talking about those thingies that connect to each other, then they're going the same."

ROBERT KUHN: Well that's a great answer.

JEANNE BAMBERGER: And she was failing in school, by the way. Because the way she thought about things…

ROBERT KUHN: How old was she?

JEANNE BAMBERGER: She was nine. And the way she thought about things was so much more complex and so, and integrated so many different sensory modalities and modes of representation that nobody, that the other kids and the teacher didn't understand her.

ROBERT KUHN: So how did gears relate to it?

JEANNE BAMBERGER: She then, there were eight teeth on the little gear and it went around four times when the big one went around once, and the question was, how many teeth does the big one have? And the other kids said, "you better count 'em." And she said, "no, it's 32!" Because 8 x 4 is 32, and then somebody said, "well, can you clap those gears?" And another little girl did this. CLAPS

JEANNE BAMBERGER: Okay so, and then we went to the computers and I said, "can you get the computer synthesizer to play that rhythm using numbers?" And at that point they had to do, they had to get into ratio and proportion, because the two slow one had to have a number that was 4 times bigger than the faster one so they could use something like 12 and 3, this could be a 12-er, as they called it, and this could be a 3-er. TAPS OUT RHYTHM So they, at that moment they had gone across all these different sensory modalities, modes of representation, including their own body action and different kinds of materials. And I think there are many, many more things that, in which different domains meet and function actively in music.

ROBERT FREEMAN: Though we don't normally teach music as though that were the case.

JEANNE BAMBERGER: That's exactly right.

ROBERT FREEMAN: Though we should.

JEANNE BAMBERGER: Absolutely.

ROBERT KUHN: Well, when this is happening there are vast areas of the brain that are involved, it's not just the auditory part. What's happening in our brain?

MARK TRAMO: The concept of that the there's a music center in the brain is, is surely not correct. The auditory system is what allows us to decode the music, makes sense of the music as we were talking about. To derive the meaning or to evoke of the emotions in a piece, one has to develop some expectations about where the music is going. So if I'm expecting Jeanne to end on a particular note, I can tell you that the anterior frontal

cortex is what is generating, what's coming next and sort of the concept of future memory that I knew already what's going to happen in that last note, that's not the auditory cortex in the superior temporal lobe, that's going to be primary anterior frontal lobe structures. If I'm watching your facial expression when Jeanne plays that note and we all smile because she suspended it for us and we had to wait for it, the meaning of that came from me reading your face as well as from the fact that this, now the visual cortex is all the way in the back behind the system is distributed, it involves many structures throughout the brain. How those structures connect from many different areas…

ROBERT FREEMAN: What are the structures measuring?

MARK TRAMO: Well, the structures measuring in the auditory system are going to measure the frequency, the duration, and the timing of the events as we listen to them, their combinations.

ROBERT FREEMAN: Patterns.

MARK TRAMO: Patterns, the anterior frontal are going to be expecting those patterns to resolve or not resolve in some way. You're going to associate them into the medial temporal lobe by recall with events that happened in your past life

ROBERT KUHN: It shows the pervasiveness of music.

MARK TRAMO: It's tapping into so much, and on the one hand it seems so simple, *Happy Birthday,* you know, the simplest thing. But when you put it altogether, it's so meaningful and it involves so much of the brain, it's astonishing.

JEANNE BAMBERGER: The different kinds of things that it calls up and, and speaks to. I mean everything from doing something together and feeling something together, to being very analytical and, and finding, structures that relate to other kinds of domains, I mean it's across the board, why music has that capacity beats me. And I don't know what that means from that point of view of the brain, what does it mean that I learn to hear PLAYS PIANO this as ambiguous? And it's scary because it's ambiguous. Now I can tell you why it's ambiguous in terms of PLAYS PIANO it needs to go PLAYS PIANO but it can also go here. It can go, I can move any one of these and I'm going to get something that's PLAYS PIANO and now it's not ambiguous any more, it's gotta go here.

MARK TRAMO: The amazing thing is that of course we think of music as being sound, right, acoustical energy. It actually doesn't exist as acoustical energy once you get past the ear. It exists entirely in the activity of tens of millions of nerve cells throughout the auditory system.

ROBERT KUHN: It starts out mechanical in the ear.

MARK TRAMO: It starts out mechanical but there's no sound in the brain, they're neurons firing action potentials and talking to one another.

ROBERT KUHN: It's electrical spikes.

MARK TRAMO: It's electrical activity which is one neuron splashing a chemical onto another and causing it to fire sparks. How many sparks it fires, when it fires those sparks, that's the code, sort of loosely speaking, the Morse code that the brain uses to say "oh, Professor Bamberger is playing this particular piece," or "she is climaxing the piece in just the right way to evoke the emotion." You need, that's what the neurons have, they actually don't have the sound per se, there's no acoustical energy in the brain. Now the pitches that we hear that make up individual notes, they can only exist within a particular range of the audible spectrum. We don't have instruments that play tones above 20,000 Hz because we couldn't hear them. So the physiology of our auditory system has to constrain the pitches that we use. Now in addition to that, when one plays different combinations of notes, we can actually see differences in the way that neurons fire.
For certain types of sounds, there's more regularity in terms of the neural firing, something Galileo wrote about when he was under house arrest for his work on astronomy. He pointed out that the timing of fluctuations and air vibrations, and therefore the fluctuations in the ear drum, and as we've measured, fluctuations in the sparking of neurons is much more regular for certain musical structures like an octave PLAYS PIANO than it is for a minor 2nd PLAYS PIANO.

ROBERT KUHN: Does that affect brain development, those types, or is brain development just enabling them to react differently, or do those tones in fact impose themselves on how the brain is being developed?

MARK TRAMO: One way I like to think about it is that we come into the world and we are primed to extract regularities in the acoustic environment and, the visual environment faces for example, we're primed to do that. Our nervous system gives us that capacity.

ROBERT KUHN: Let's understand. Music principles that are built into the brain, hard wiring. Or out in the external world?

MARK TRAMO: They're out in the external world, we come into that world, it's differentiation between nurture, nature and nurture's breaking down. There's a continual interaction between what we're born with and what exists in the world. It's part of our nature to change with the environment, they're inextricably linked.

ROBERT KUHN: It's the plasticity of the brain.

MARK TRAMO: The plasticity of the brain, and what's new, we're understanding that's new about it is we're not talking about just plasticity in three year olds, we're talking about that the brain, although less plastic, it continues on into adulthood, it can change well into the 7th, 8th decade.

ROBERT FREEMAN: There has to be for any piece of music to make sense, whatever culture it's in and whether it's high art or pop art, there has to be some kind of repetition, which is to say you played the beginning of the 1st Beethoven Sonata, if you did two measures of that and then two measures of the 2nd Beethoven Sonata, two measures of the 3rd Beethoven sonata, all of which are apart of Opus II, you would get something which makes no sense.

JEANNE BAMBERGER: Even if you played the beginning of the first movement and the beginning of the 2nd Movement…

ROBERT FREEMAN: It still wouldn't make any sense.

JEANNE BAMBERGER: Or if I played… PLAYS PIANO

LAUGHTER

ROBERT FREEMAN: Try the beginning of the first Prelude of the Well Tempered Clavier of Bach.

PLAYS PIANO

ROBERT FREEMAN: Now you could go on forever and ever doing that, but it's not a piece of music until it goes to the second harmony in the second measure.

JEANNE BAMBERGER: Okay, but without repetition, then there would be no coherence.

ROBERT KUHN: Yeah! So you need both.

ROBERT FREEMAN: So you need both.

ROBERT KUHN: Suppose we go to a different culture, how does that relate?

JEANNE BAMBERGER: All I know is that if I listen to Chinese music, if I listen to Chinese music, I have the feeling that it goes on and on and on. I think if you can't tell where the stops and starts are, then it's like listening to a foreign language that you don't know, it also seems to be going on and on until you learn where the stops and starts are,

in other words, "how to chunk it," then it, and what generates boundaries, what generates edges.

ROBERT FREEMAN: I've been making comparisons for years to baseball games, that's my passion, my avocational passion. You cannot tell what you're doing in a baseball game if you don't know something about the basic structure of it, it seems endless in much the same way. That's what I get out of cricket, I don't know what the rules are I don't know what the objectives are.

ROBERT KUHN: So it goes on and on.

ROBERT KUHN: So doesn't this mean that music is more culturally based than genetically determined?

MARK TRAMO: There are some data of cross cultural studies that have been done looking at how Stanford undergraduates, and how Balinese villagers who have never seen a pair of headphones, how they perform on tasks. So if I were to play a sequence for you like PLAYS PIANO and you had to decide how well that last note completes the sequence. Right, if you were to look at the probe tone method PLAYS PIANO then you would have some opinions about how well the last note. Now, a reasonable proportion of these Balinese villagers will rate how well that final tone completes that sequence, the Gestalt of good closure, very similar to the way that undergraduates in America might perceive the goodness of, of fit in terms of the closure there.

JEANNE BAMBERGER: I just have to stay that that study, has been, has come under a lot of criticism, what they give as stimuli are not related to the music that people in the culture know. So that it's some kind of, it may demonstrate something, but I don't think it demonstrates something that has to do with the way in which we make sense of <u>real music</u>.

MARK TRAMO: But isn't that part of the power of the result, though they don't know anything about this music, it's being played on an equal tempered keyboard, it's presented to them, and yet they behave in the same way that Stanford undergrads behaved.

ROBERT KUHN: Talk about consonance and dissonance.

JEANNE BAMBERGER: If you move it all from any context and not PLAYS PIANO just do that. Okay, then, that would, I don't know whether that's cross-cultural or not. I doubt it because actually in Yugoslavia they sing, they sing, uh, songs like this….
PLAYS PIANO That's how they sing. I mean we used to do it in the 13th, 12th century like this. PLAYS PIANO We did like that. But they actually do this PLAYS PIANO. And that's not considered dissonant at all.

MARK TRAMO: There's a whole semantics around the use of the terms consonance and dissonance.

ROBERT KUHN: Is that culturally determined?

MARK TRAMO: Clearly consonance and dissonance is culturally determined, there are universals…

ROBERT KUHN: What are some examples?

MARK TRAMO: Well there's still context there. If we were thinking in terms of film, let's think if we're watching a movie together. PLAYS PIANO You just hear CRASHES PIANO. It's not going to be a happy point in the film. I mean the emotion that we associate with that, which is very much learned, but we do see some behaviors even in four month old children that say they can tell the difference PLAYS PIANO between that and something like PLAYS PIANO that.

ROBERT KUHN: Let's talk about the impact of music on children, something that many people know as the Mozart Effect, that theoretically listening to music will help you do better on tests.

ROBERT FREEMAN: As a music school director, you can imagine that, that's something that I would love to see proven.

MARK TRAMO: Well, let's do the example with our host so we'll have an opportunity, and I think that it is important to, to consider what the details are in the particular studies that came out of Irvine that are referred to as the Mozart Effect. So I'm going to, I'll administer one trial of the kind of task that was involved in this to you, and we'll imagine that there are three Robert Kuhn's, one of them was in Dressing Room 1 listening to ten minutes of Mozart's PLAYS PIANO the Sonata For Two Pianos in D Major. K 448. There was another Robert Kuhn there who's in complete silence, we don't really know what he was thinking about in complete silence, but he was there. And, there might be another one listening to a relaxation tape, or maybe Phillip Glass, or maybe even trance music. And then after that ten minutes we ask you to come and join us and what we did was to say, okay, I took a piece of paper and I folded it up. You didn't see me do that, I folded it up and I cut it, see I made a little snip over here, and I made another little snip over there. All right, now you have five seconds, all right… they didn't give five seconds, but we're going to do it that way, and I want you to tell me if I unfolded those pieces of papers, which one will match what I did with that piece of paper? You're not supposed to touch the materials.

ROBERT KUHN: Oh, sorry I like to cheat.

MARK TRAMO: Quickly.

ROBERT KUHN: The obvious answer would be this, so I think you're trying to fool me.

MARK TRAMO: All right, so in fact if we unfold this piece of paper… we see that… that actually was, you got it correct although you thought the obvious one was actually the wrong one, so these two match, now that's the task, so you do better on this task for 10 or 15 minutes after you've listened to Moz-, not, not any more than that, but you do better on this particular task. Now that's promising in the sense of okay, we've shown some effect, there is an effect there, but it's very short lived, it can be explained, it could be explained by non-cognitive mechanisms that have to do with arousal and positive mood induction. So, why that should be, what that relates to in terms of what the underlying brain mechanisms are, are difficult to sort out.

ROBERT KUHN: So what this does is focus public attention on the fact that music may be important to intellectual development in our children.

JEANNE BAMBERGER: Without saying anything about why. I mean, there's no, and nobody has even tried to say, and I think the people who develop the experiments are, agree that they can't account for it. How can you account for this effect?

MARK TRAMO: We need more data. What's exciting about the work that was done in Irvine with respect to the Mozart Effect was that it was in the right spirit. Music taps into so many different aspects of cognitive as well as emotional processing that it would be hard to believe that it wouldn't have some sort of a positive, I mean, if we're talking about phonological processing and language, learning how to read. Well listening to music, you have to be able to decode very complex sequences, so that may confer an effect there's some evidence that that may be useful in the treatment for dyslexia. If you think of it in terms of proportions and ratios and symmetry, that would confer to mathematical ability that that, that that might be relevant for.

ROBERT KUHN: A lot of people know there's a relationship between math and music.

JEANNE BAMBERGER: It only goes one way. There are very few musicians who are interested in math.

MARK TRAMO: There is one study from a Providence group that has shown that if you take first graders and enroll them into a rather intensive arts program that includes music training that emphasizes sequencing, that their math scores, they start out behind in kindergarten, by the time they're finished in first grade, they're actually ahead of the rest of the class in math and they've caught up in reading. Those kinds of longer term, now what happens in ten minutes? But those longer term effects, what happens from the time

that you begin to study piano at the age of 4 to 9 years old? Over that period of time, we need to do those experiments, we need to collect the data to be informed about whether there should be a national effort. One way to think about it is that it's what music is fun for many people. If one is trying to draw children into an activity that will exercise the brain, help to develop strategies and cognitive structures, use something that's fun. Don't have drilling them on questions, music encompasses so many things that have to do with cognition, perception and motor function, that if the individual, apriori, likes music it's not for everybody but if that gravitates naturally towards music, which so many children do, take advantage of it.

ROBERT FREEMAN: I have a sort of dream for the future of a musical society in America that, just as with athletics, uh, where we, all kids are involved in athletic activity, uh, when they're 5, 7 years old and they should be, and new evidence that we should be doing that more than we're doing it, but people are always a little reluctant to do it about music because it's always maintained, well what would happen if he became a professional musician? We don't, what we don't need is more professional musicians, what we need is a whole army of avocational musicians, of people who take great pleasure in being involved with music from an early age, it's truly one of God's great gifts to humanity.

MARK TRAMO: music is one of the things that help bring us together, form collectivities and succeed in that sense. As humans we never would have survived, we would have been eaten up and killed, if we didn't bond together and form civilizations so that we could go fight the animals that were gonna, we wouldn't have made it this far. The fact that you can develop social bonds, that you can cement the collective identity, if we think a little about collective ego in Freud and Jung, what ritual have you ever been part of that music wasn't present?

ROBERT FREEMAN: I have a bunch of women on the campus of the University of Texas I'm very proud of who decided when they were freshmen that Mozart and Beethoven, for example, were for everybody and that they would, as young art students, invite the non art students on this vast campus of 51,000 people to accompany them on dates to go to artistic events. They got a whole cottage industry that's going, sort of populace spirit of the state of Texas is behind the idea that Beethoven should belong to all of us.