MMM Podcast Transcripts: Dr. Mark Tramo

There are several articles supporting the idea that music can benefit the brain throughout development. Can learning an instrument or participating in a choir late into adulthood still be advantageous for brain health?

Summarized Response: It is very hard, if not impossible to do a randomized controlled trial using any one aspect of lifestyle because there are so many variables that are moving that it's hard to isolate that one variable as being responsible for an outcome. That being said, the way we learn new things is not by making neurons but by making new connections. So, we can rationalize that if you maintain a mentally active lifestyle, then you are going to be making new connections and we can infer that we are making new connections which would mean an advantage in terms of maintaining brain health later in life. This brings us to music. How many things can a human do that involve so many parts of the brain all together in real time? There really aren't that many things that we do that can do that. If you are older and you took piano lessons when you were younger or even if you didn't and you want to learn how to play the piano for the first time, you're going to be engaged. You're going to be using your motor system, your somatosensory system, your visual system, your vestibular system, and obviously your auditory system. So, how many things are there that actually could involve that many parts of the brain to keep the mind active so that the brain is A. forming new connections and B. losing established connections at a slower rate?

Dr. Tramo: It can be advantageous and it's interesting you use that term because when we get off this podcast I have to provide some edits and comments to the AARP global council on brain health who convene about 10 of us in washington DC who work on music and the brain to write a consensus statement about the potential benefits of music related activities in seniors. We would never want to discourage any mental activity. I think one of my patients has a mahjong club. I just had another one who plays cribbage regularly. So we kind of use that as an index - is she still winning at cribbage or is she starting to have trouble? So here we get into the world of rationalism versus empiricism. What has turned out with these lifestyle changes in late life and what they can do to maintain brain health where that is, is that it is very hard if not impossible to do a randomized controlled trial using any one aspect of lifestyle. Because what are you going to do? Tell everybody to stop everything else? There are so many variables that are moving that it's hard to isolate that one variable as being responsible for an outcome. So we are a little bit handicapped in being able to do that kind of a study. It's hard to do. The one thing lifestyle wise that has been consistent but not absolutely in every study is some minimum of exercise is good for the brain. It turns out to be two hours a week, so I tell my patients at a minimum to try to take a brisk walk 20 minutes every other day or 30 minutes every other day. It's very hard to

empirically prove. Now, rationally, if we become rationalists about it, then we do know from a lot of different sources - young people, middle aged people, patients who have brain damage - that the brain can make new connections or appear to learn new things throughout life. The way we learn new things is not by making neurons but by making new connections. So, we can rationalize that if you maintain an active, mentally active lifestyle, - and that can be anything, it doesn't have to be just music - but if you are doing new things and learning new things, then you are going to be making new connections and we can infer at least that we are making new connections and that that would confer an advantage in terms of maintaining brain health in later life. So, I think as long as scientists are open with the public that although we at heart are empiricists and do science in that tradition of empiricism, there are some things that we can't apply that particular scientific method to - one of them is lifestyle issues later in life - But that on a rationalist basis it makes all the sense in the world that you would want to stay active mentally, that you would want to be doing some new things mentally. This brings us to music. How many things can a human do that involve so many parts of the brain all together in real time? There really aren't that many things that we do that can do that. So, clearly playing games has an element of that too because it's in real time and you have to think, you have to do problem solving, it involves usually visual stimuli. If you are older and maybe you took piano lessons when you were younger or didn't and you want to learn how to play the piano for the first time, you're going to be learning to do something new and you're going to be progressing in your lessons and you're going to be engaged. You're going to be using your motor system; your somatosensory system; if you're reading, your visual system; and obviously your auditory system. Also your vestibular system. So, how many things are there that we could say "let's get elders to do" that actually could involve that many parts of the brain and that is new in real time? I think the other one that is often said is learning a language. If you have the opportunity to actually converse with someone, for example, and learn just doing it silently. Or you have an interactive game, game learning a new language - that would be another possibility for how to keep the mind active so that the brain is A. forming new connections and B. losing established connections at a slower rate. That was a big issue for our global council because the AARP really wanted us to address healthy members. We always were slipping into "Oh well there's this study in Parkinson's disease..." or "in my practice, for patients who have alzheimer's disease and get agitated..." but that's only a portion of their membership. They want a strong statement about if you're fifty five or sixty five and healthy, what can music do for you? And as a council we had to say alright we will rationalize that one for you.

As a neurologist and researcher you have found both theoretical and clinical benefits of music. Why do you think music is not often utilized in our healthcare system, and what might change this in future years?

Summarized Response: The short answer is economic. There are centuries of anecdotal evidence that music improves the quality of life. In order for third-party payers like insurance companies and Medicare to pay for services, one has to do fairly rigorous clinical trials. This is one of the missions of The Institute of Music and Brain Sciences, to garner support to be able to do randomized controlled clinical trials with patient populations like the Music Mends Minds populations in order to demonstrate what the benefits might be. Until one sees randomized controlled clinical trials published, the application of music in the clinical arena is always going to be ad hoc and out of pocket. So the question then becomes, who is going to fund randomized controlled clinical trials that incorporate music? To me, it seems that the payoff is altruism in and of itself in that it is going to require philanthropic funds and I think one of the great things about Music Mends Minds is that it has been able to really rally a fairly large group of individuals with neurodegenerative disease and have a relationship with them that would be needed if we were able to get some funding to do randomized controlled clinical trials. Music Mends Minds has the potential clinical material for us to approach the patients through the foundation to say "oh there's a randomized clinical trial on X". Having a resource like Carol's Music Mends Minds, we have established a network of individuals who are open-minded and motivated who could potentially provide the kind of clinical material and the large numbers that we need in order to be able to do the randomized controlled clinical trials.

Dr. Tramo: The short answer is economic. There are centuries of anecdotal evidence that music improves the quality of life - not so much mortality, but morbidity. In order for third-party payers like insurance companies and Medicare to pay for services, they have to see that an intervention - I think we are all realizing this now, it has become much more apparent with the pandemic that one has to do really fairly rigorous clinical trials before one can believe that something actually works.

So this is one of the missions of our institution, Music and Brain Sciences, which is to garner support to be able to do randomized controlled clinical trials with patient populations like the music mends minds populations in order to demonstrate what the benefits might be.

Currently, there are many board-certified music therapists, there's a new neuro-music therapy board certification that Michael Thaut has developed that is very convincing about the potential benefits, but really until one sees randomized controlled clinical trials published not in music

therapy journals and not in nursing journals but in reasonably high impact medical journals, the application of music in the clinical arena is always going to be ad hoc and out of pocket.

Even to get hospital administrators interested in bringing music, which is maybe even easier than getting the third-party payers to buy into the idea that they need to soundscape hospitals and improve the ambiance of hospitals using arts and entertainment, there has to be data that are collected. Now, I don't think it's widely understood that all of these great drugs that we have for treating all of these diseases, including all the diseases that the music mends minds population suffer from, that funding really does not come from the federal government. That comes from the for-profit private sector and it is the pharmaceutical companies that are developing the drugs who sponsor the randomized controlled clinical trials, almost entirely. And of those trials, the vast majority of those trials fail and part of the issue with the expense for new drugs is that there's so much funding that goes into trying any new drug if you only get 1 out of 10 that works, you have to mine as much funding or profit out of that one that worked to make up for all the costs of the failures.

This is the underside of this question of big pharma and the cost of drugs has a lot to do with the rigor that is required to get FDA approval and how often drugs fail, like our antibody tests for COVID-19 - They're not good enough to do the mass screening. We are getting a taste of that in the diagnostic realm because of the antibody tests but it's even more difficult in the treatment realm. So the question then becomes, who is going to fund randomized controlled clinical trials that incorporate music? We got a small amount of funding from the Grammy Foundation and combined it with some philanthropic funds that the institute got to be able to do our study in premature infants who were suffering pain from blood tests, to use music to destress them after they have the test.

When we founded the Institute for Music and Brain Science in 2002/2003, we thought that maybe the music industry would be what the pharmaceutical industry was to drugs, the music industry might be that for us to do the clinical trials. I learned a couple of things, one was we thought "our heroes are getting old and some of them are rather wealthy, so won't they buy into this?" and the issue there is that actually a lot of the artists aren't that financially secure. All you have to do is look at the canyon club in Agoura Hills, near where I used to live, to see who plays at this relatively small venue. A lot of them are giants of my youth. It's actually the case that a lot of entertainers are not as wealthy as you think they are to be able to be philanthropists and

most of our financial support at the institute came from manhattan bankers, mostly business people from manhattan who were either friend of mine from college or I had met through Harvard. So it remains a question of, yea big pharma has the payoff when they do develop a successful drug, who is going to support randomized clinical trials with music and what is going to be the payoff for them?

To me, it seems that the payoff is altruism in and of itself in that it is going to require philanthropic funds and I think one of the great things about music mends minds, what the foundation has been able to do is really really a fairly large group of individuals with neurodegenerative disease and have a relationship with them that would be needed if we were able to get some funding to do randomized controlled clinical trials.

Music mends minds has the clinical material or potential clinical material for us to approach the patients through the foundation to say “oh there’s a randomized clinical trial on X, we are particularly interested in Parkinson's disease, by the way, there’s a randomized controlled clinical trial that we want to do looking at drumming and if it might decrease the risk with Parkinson's disease and when we do that study we want to also collect some scientific data like, John Iverson at UCSD is an expert in rhythm perception and production and a top-notch scientist with extraordinary skills in being able to do things like measure movement vectors in 3D and quantify all the potential benefits.

Having a resource like Carol’s music mends minds, Ping Ho’s UCLA arts and healing, we have established a network of individuals who are open-minded and motivated who could potentially in the future provide the kind of clinical material and the large numbers that we need in order to be able to the randomized controlled clinical trials.

**** Biographies**
Katie Butler: Hi, I’m Katie Butler. I have had the pleasure of working with Dr. Tramo closely with his institute of Music and Brain Science project, I am a Music Mends Minds student volunteer from UCLA and aspiring profession in the world of music cognition, so I am really excited to be here and excited to hear your thoughts, Dr. Tramo.

Brandon Carone: My name is Brandon Carone, I also work as Carol’s assistant for Music Mends Minds, I graduated from UCLA last year and have been interested in music cognition for as long as I can remember. I am currently working at the UC San Diego Veterans Medical Research Foundation to conduct research on traumatic brain injury.

Dr. Tramo: Very cool, well our future is in youth, right Carol?

Carol: Yes!

Dr. Tramo: Two propitious individuals for the future I think.

Katie: Well, it is my pleasure to introduce our first interviewee for the Music Mends Minds public education podcast. Dr. Mark Tramo M.D., Ph.D. is a neurologist affiliated with the Ronald Reagan UCLA medical center and the Los Robles hospital and medical center in Thousand Oaks, California. He is also a lecturer at the UCLA David Geffen school of Medicine and the UCLA Herb Alpert School of Music and a lifeline musician and songwriter. A 2015 recipient of the UC President's research catalyst award, Dr. Tramo has been awarded grants from the national institute on deafness and communication disorders, the national institute of neurological diseases and stroke, Grammy Foundation, and other foundations to conduct research on the neuroanatomy and neurophysiology of music perception and cognition over 25 years. Aside from founding the world's first music and brain course at Harvard University, Dr. Tramo has given lectures on music and the brain at Carnegie Hall, Lincoln Center, the national academy of sciences, Yale, Stanford, Duke, and numerous other world class establishments. Thank you so much for being here, Dr. Tramo.

Dr. Tramo: My pleasure, thanks for having me, Katie.

How did Dr. Tramo get interested in the electric guitar?

Summarized Response: Everyone who is around my age still has Beatlemania. I mean it really is an example in the extreme of collective behavior. The Beatles had the money, they had the fame, they had everything but they were tough on themselves, they just kept getting better and better and moving music forward and doing new things so if you're growing up learning to play guitar, you are trying to keep up. You get the song books, and there's chords you didn't know that you were learning. Kind of a weird thing that happened to me was in 1964 there really weren't a lot of, especially young kids, playing electric guitar. Fortunately for me, my music teacher would let the last 5 minutes of lessons be playing more like ventures and Dick Dale 50s rock and roll where he would play rhythm and I would get to play lead for 5 minutes. In 1964 I was signed to two shows at the World's Fair and that was significant to me because with respect to the Beatles, The Ed Sullivan show was in February, A Hard Day's night was in August, and then in December I was signed to two shows at the World's Fair and I felt like, "Hey, I'm gonna be a Beatle!" So it really got imprinted on me. That love of music that came at a very early part of my life I think inspired me to want to stick with it and continue playing and writing. But, it really is the case that I think a number of us in the field do have music backgrounds. Nobel laureate David Hubel is one of our founding board members and he said in his society for neuroscience

autobiography, "I would never give up my love of Bach instilled in me by my grade school piano teacher for any degree of success in neuroscience." And that's coming from someone who won the nobel prize.

Everyone who is around my age, we still have Beatlemania. A lot of people have Beatlemania, Carol probably still has a little bit of it. I covered in my seminar course, my music, mind, and brain course at UCLA, just from a cultural, social perspective, I mean it really is an example in the extreme of collective behavior and actually the first name for our band was Neil Smelser group which was kind of corny because the bass player and I had taken a sociology course to round out our liberal arts education and we read a book called "theory of collective behavior" so of course we thought we should name the group after this guy, Neil Smelser. He writes about crazes, panics, which we just saw- we are in the middle of a collective behavior phenomenon with panic- all the way to things like revolutions. How do large groups of people become mobilized and if you were witnessing what was going on in 1964 and 1965 with the Beatles, it really was a phenomenon of collective behavior and then they sort of superseded the popstar thing. They had a great professor, who was their producer basically, who was their professor or the equivalent of having a great music professor kind of one on one tutoring, George Martin. As John Lennon said about George Martin, "we were what we were in the studio because of George Martin". They had the money, they had the fame, they had everything but they were tough on themselves, they just kept getting better and better and moving music forward and doing new things so if you're growing up learning to play guitar, you are trying to keep up. You get the song books, and there's chords you didn't know, and I'm learning all these chords now, and it got to the point where "oh god, how are we going to do Sgt. Pepper's in a band?" You can't do it. But, it really is the case that I think a number of us in the field do have music backgrounds, more of them are like, Peretz is classical guitar, Zatorre is organ, there really weren't many pop rock people in academia. Dan Levitin is a pop rock person. I think our love for it, just the love that was instilled. It's like nobel laureate David Hubel is one of our founding board members said in his society for neuroscience autobiography, of course none of us could say it but David could say it, he said: "I would never give up my love of Bach instilled in me by my grade school piano teacher for any degree of success in neuroscience." And that's coming from someone who won the nobel prize. So I think many of us, because of our love for music, were motivated to go into it. Part of it is probably we were scared about the job market in music and how difficult it could be. If you have a college education and some other options, how difficult it would actually be to make it as a recording artist. That has always factored in for me as I was basically a work study kid on scholarship, it wasn't like I had anything to fall back on. But, that love of music that came at a very early part of my life I think inspired me to want to stick with it and continue playing and writing.

Brandon: Yea, and I definitely understand that because I started playing guitar at 7 also and I kind of went through the same thing. I wasn't about to get signed by columbia records but I was trying to decide if I wanted to take the music route or the neuroscience cognitive science route, and I'm really happy that I'm trying to find ways to merge the two, my two passions.

Dr. Tramo: Yea, well kind of a weird thing that happened to me was in 1964ish there really weren't a lot of, especially young kids, playing electric guitar. Fortunately for me, my music teacher would let the last 5 minutes of lessons be playing more like ventures and dick dale 50s rock and roll where he would play rhythm and I would get to play lead for 5 minutes. And so, in third grade the nuns at St. Mary's in the Bronx asked me if I would play during the Christmas show. There really weren't any kids, it was sort of almost like the organ grinder monkey thing, it was an oddity to see a little 8 year old with an electric guitar playing ventures on weekends. Little did we know there was a talent scout from the world's fair in the crowd who afterwards went up to my parents, always weird to see a stranger talking to your parents wondering what you did wrong, and so he signed me to two shows at the world's fair in 64 he signed me and that was like, the ed sullivan show was february, hard day's night was august, december I was signed to two shows at the world's fair, "Hey, I'm gonna be a Beatle!" you know? So it really got imprinted on me. My psychologists talk about peak experiences, so probably that was a peak experience in third grade having a couple of shows at the worlds fair and older kids backing me. Except, my mom hated long hair so I had to have a crew cut and looked more like Pat Boone or the Beach Boys than the Beatles. That's okay, it was still 1964.

What is the most astonishing thing that you have found in music throughout your life?

Summarized Response: I would have to go with the phenomenon that music and musicians can bring about such a strong collective response. Why would teenagers attack policemen and break windows just to see a group of singers? Darwin would have a field day with that because he thought a lot of music had to do with sexual selection and emotional expressions in animals and humans. The military has been using music to demoralize soldiers or interrogate prisoners. So I guess the astonishing thing for me is, in addition to the power of music to heal and the power of music to do all these great things, the power of music to turn teenagers into this rioting mass and to scare soldiers not to attack. The power of music to do those things, as someone who loves music and plays music, but to see its power, in such a large collection of people that way, that to me is the most astonishing thing about music.

Dr. Tramo: Okay, that's kind of a tough question. I guess I would have to go back to like, why would teenagers or even preteens, most of them girls, punch and kick and push policemen and break windows, just to see a group of singers?

Brandon: Meaning the Beatles, right?

Dr. Tramo: But I mean, in general, just the phenomenon. Darwin would have a field day with that because he thought a lot of music had to do with sexual selection and emotional expressions in animals and humans. I show these pictures, I actually wasn't quite aware of how bad it was. But there's these pictures of these cops being pushed and thrown to the ground and making a cop chain to prevent people.. You know? Like, why? It's astonishing to me that just because- now it has a lot more to do with, music is one reason and there are a lot of other reasons- but still the basis for meeting the Beatles was the music. So why would that phenomenon ever occur? And then of course the sad part of that is they don't even want to talk about being the Beatles and they think we were crazy. I mean I don't know about me as a little kid but they just thought people were nuts. They were like "What are they doing? What's the big deal? Why are they doing this?" And the bad part of it is, with all of that hero worship, which is just interesting from a psychodynamic standpoint, two of them were murder victims. One was killed and one was almost killed. That's 50% of the band. When they stopped touring because of the Jesus Christ comment and the popularity comment, they were getting death threats and they were worried about snipers and the concerts and if there was a pop they thought it was a gunshot. Why? Katie and I now with the Institute and updating our website which desperately needed repair, we are working with Danielle Stein who is a graduate student in musicology and she works on military uses of music and how the military has been using music to demoralize soldiers or interrogate prisoners. So I guess the astonishing thing for me, I mean we know this with Carol with the power of music to heal and the power of music to do all these great things, what is this power of music, that.. You know, the power of music to turn teenagers into this rioting mass and to scare soldiers not to attack. The power of music to do those things, as someone who loves music and plays music, but to see its power, in such a large collection of people that way, that to me is the most astonishing thing about music.

Brandon: Yea, I saw the documentary on the Beatles and I saw all the stuff that you are talking about and I just had no idea. I had grown up listening to the Beatles because my dad loves the Beatles but I didn't know this history behind it and it's really crazy to learn all that.

Dr. Tramo: Yea, and that was before a lot of the work. I mean, that was a couple of albums.

**** Carol welcomes Dr. Tramo**

Carol: I personally also, Dr. Tramo, want to take this opportunity to thank you for all you've done silently and in full audibility for Music Mends Minds. To meet you 6 years ago, we were just a seedling and somehow you invited me on campus to meet your constituents, all of your national researchers. I wasn't quite clear where we were going but of course I was honored to have the introduction and the invitation. You then handled a Q&A for us at the Semel Institute when Serene Michelle Dillman launched our Fifth Dementia documentary that has gone out globally, and today, here we are welcoming you as our first interviewee for our major step in academics and to connect Music Mends Minds further academically. And so I am really on a bent knee to see you today, face to face. I wish we could have a hug, but those days I think are about a year or 18 months away, which is scary!

Dr. Tramo: Well, we are touching, it's just the sound waves you're producing are touching my ear drums so we are in touch.

Carol: Thank you, and including my heart. I want to also take this opportunity to thank Brandon, who has been with us as a UCLA assistant for many years and now he together with our darling Katie Butler, who is bringing you into the family more intimately, and thank you for that, Katie. And so really, to all of you, this is a major launch of a new trajectory for music mends minds and music cognition. So, welcome Dr. Tramo. Thank you to our students and to Ross Goldberg who is doing a masterful job for us as governing chair. I am going to sit back here and just enjoy the three of you chatting together. Thank you, Dr. Tramo.

Dr. Tramo: Well, thank you, Carol. I hope the symposium was helpful to you and the foundation and as much. There were a lot of speakers talking about active areas of research both clinical and basic science, so I hope that the multicampus president's research catalyst award that my colleagues and I got in 2015 was useful for just these types of endeavors.

Carol: Absolutely, and it literally connected you with MMM and vice versa and for that I am eternally grateful so thank you so much.

Dr. Tramo: Well thanks for everything you do for these patients. Of course, I share with you many concerns about our seniors who suffer from neurodegenerative disease and wholeheartedly support the effort to improve their quality of life through music and the arts.

Carol: Thank you so much, and as a caveat, my darling Irwin, who had a parkinson's diagnosis 14 years ago, the dementia came 3 or 4 years ago that really messed him up dreadfully, and he has now achieved 1 year past his prognosis for being alive. I attribute nothing but unconditional love and music to his being here a year later. I personally am sharing the benefits of music and the brain.

Dr. Tramo: There's something to celebrate about. We could use a few of those these days.

Carol: Absolutely. So thank you Brandon, Thank you Katie, and let's get on with the show!

You mentioned some of the grants you got in the past, what was it like navigating the scientific community at the beginning of your career when music cognition was an emerging field?

Summarized Response: What it was like was being stubborn and being a little bit rebellious. When I entered the Gazzaniga lab, the deal was, because I had trained in neurology, I really knew neuroanatomy, and Mike needed someone who did neuroanatomy and he had a project in the lab that we called the brain print project. At that point in my research career, I would be doing all the neuroanatomy for the brain print project, which really wasn't my thing, but it became my thing, and then if I would put half my time towards that for the lab as a whole, then I could have the other half doing what I wanted to do, but with a lot of constraints like it better be good, and it better be experimental, and you better know what you are doing. When I moved from Cornell to Dartmouth, John Sheve Beruccio was in psychology there and we got together and he had been doing research on chord perception and since I was mostly a rhythm guitarist and songwriter, that's what I was interested in, like why does this chord progression work? Or why do I pick that chord instead of this chord? And I had that basic question just from writing. Again, no way to plan for that but by having an open mind and looking for ways to do things, the opportunity presented itself and we did experiments on musical chord progressions with stroke patients and split brain patients. Once we had the preliminary data from those experiments and from my timbre experiments, the name of the game with the NIH for getting grants is you almost have to have already done the experiments that you are proposing to get money to do. It's so competitive. There's not a big difference between being creative in science and being creative in music and the arts. Because, when you get an NIH grant, usually they're somewhere between 3 and 5 years and in that 3 to 5 year period the standard is one paper a year minimum. So if you don't have a couple of hits in high impact journals over those 5 years you're probably not going to get your next grant the way you're not going to get your next recording contract or your next major league baseball contract. When you have your money from the label to make a record and they're paying for your producer for you, within that 3 or 5 years, you better have a couple of hits, or they're not going to sign you after your contract runs out. And it's that way with the NIH. I mean, you do have to keep up, no matter what field you are in, but if you're not breaking new ground, not sharing your knowledge with other people, as opposed to really being out there and realizing that you're going to be reevaluated every 5 years or so, you may not be able to continue on in that capacity and may have to find something else to do in 5 years if you can't get your grant.

Dr. Tramo: You know, that's a great question. What it was like was like being stubborn and being a little bit rebellious, I think. When I entered the Gazzaniga lab, and this is an important lesson for all the young people, when you go to graduate school where you do your post docs, you don't go by what university you're going to go to really. It's always great to be part of a great university and that should factor in, but really it's about the lab that you're going to do your research in and what methods you're going to learn, what techniques you are actually going to use. So, the deal was, because I had trained in neurology, I really knew neuroanatomy, and Mike needed someone who did neuroanatomy, so he had a project in the lab that we called the brain print project. When MRI came out, Mike had the correct idea that you can do computer modeling of the brain's surface and generate flat maps of the cortical surface with the sulci and gyri. When you unfolded it it would look like a fingerprint and then you would have basically people's brains and you could compare them for similarities and differences based on their flat maps. So the deal, basically, I mean I didn't think of it this way at the time but now that I'm older and kind of understand running labs, it was sort of the deal was okay you're going to devote X percent, I think it was 80% to research, 20% to seeing patients. But 80% to research and half of that 80% would be doing all the neuroanatomy for the brain print project, which really wasn't my thing, but it became my thing, and then if I would put half my time towards that for the lab as a whole, then I could have the other 40% doing what I wanted to do, but with a lot of constraints like it better be good and it better be experimental and you better know what you are doing. I had the great fortune of moving from Cornell in Manhattan to Dartmouth. A little bit of a culture shock for really a new york city kid but a great place, I mean a great university. John Sheve Beruccio was in psychology there and he was one of the few cognitive psychologists in the world working on music cognition. He had done his thesis in Harvard psychology when he was a violinist in the Harvard orchestra as a student and we got together and he had been doing research on chord perception and since I was mostly a rhythm guitarist and songwriter, that's what I was interested in, like why does this chord progression work? Or why do I pick that chord instead of this chord? And I had that basic question just from writing. You throw out over 90 % of what you write, so why does this sound right and this sound wrong? I kind of had a build in question. And John Sheve was working on these sorts of things. Again, no way to plan for that but by having an open mind and looking for ways to do things, the opportunity presented itself and we did experiments on musical chord progressions with stroke patients and split brain patients. Once we had the preliminary data from those experiments and from my timbre experiments, the name of the game with the NIH for getting grants is you almost have to have already done the experiments that you are proposing to get money to do. It's so competitive. At a minimum you have to have proof of principle: that you actually can do the experiments and that they might work. So because of the support that the program project as a whole had, I had some time to work on that and get preliminary results and get my first NIH grant, and that sort of

opened the door. Once you're in the system, then there's a little bit of a mutual interest in continuing one's career going, at least in the pre 9/11 days when funding was better than it is now. The 90s, congress declared the 1990s the decade of the brain and there was a lot of funding, a lot of funding meaning abou 1 in 5 grants got funded, whereas now it's probably about 1 in 12 grants that get funded. So you have to kind of get into the system and prove yourself and then once you do that, you continue on. That actually got me more curious about neural coding and what those neurons were actually doing in the auditory cortex, so that's when I got my deafness institute award and they allowed me to matriculate in graduate school at Harvard as part of a physician scientist award, which is how I got to do research on neural coding of musical sounds and voice in the auditory cortex of alert macaques. That was sort of the neural coding side, the experimental psychology side, the neurology side, the legion effects side, and then the brain imaging side- sort of collecting all these tools that you need to apply methodologically to the experimental questions that you have and that's sort of how my career developed.

Brandon: Yea, the list of grants that I saw was quite impressive so it looks like you've had quite a successful career.

Dr. Tramo: Well, many of your science professors at UCLA have at least as many and many many more than I and really I guess we don't tell young people that going into science, and I think Katie has heard me say this, there's not a big difference between being creative in science and being creative in music and the arts. Because, when you get an NIH grant, usually they're somewhere between 3 and 5 years and that's it. It's like baseball, they don't even give many 5 year contracts in football or baseball. So, what has to happen is that in that 3 to 5 year period when you have your money from the label to make a record and they're paying for your producer for you, within that 3 or 5 years, you better have a couple of hits, or they're not going to sign you after your contract runs out. And it's that way with the NIH. You get a 3 to 5 year grant from the NIH you have to, I mean the standard is one paper a year minimum. So if you don't have a couple of hits in high impact journals over those 5 years you're probably not going to get your next grant the way you're not going to get your next recording contract or your next major league baseball contract. So the difference between being in the creative world of academia, which there's nothing quite like it, but you do realize that, I heard George C Scott Carol once say, Larry King asked him, "so have you encouraged your children to become actors?" and George C Scott said, "no" and he said "well, why?" and George C Scott said, "well, it never solidifies. You're always going from one audition to the next, and one script to the next. You don't have a job. It's one job and then another job like a contractor." It's very much that way, all of your professors in science at UCLA, or most of them are going- now UCLA values education actually so the teaching part at UCLA does matter a lot to UCLA, it doesn't so much

at Harvard. It's almost like it's taking away from you competing internationally, so it's almost discouraged at Harvard to actually be teaching undergraduates because you're really supposed to be writing papers and journals and giving talks and competing for a nobel prize. But undergraduate education is hurting because of that but at the same time, graduate education prospers because of that because the labs are so active because the professors are so insecure about getting their next grant so there's a lot of research for graduate students to do to keep things going. So, you're going to make a decision eventually as you evolve or you're going to have a career where it does solidify, which in some sense people worry then about stasis and doing the same thing over and over again and not learning anything particularly new. I mean, you do have to keep up, no matter what field you are in but not breaking new ground, not sharing your knowledge so much with other people versus really being out there and realizing that you're going to be reevaluated every 5 years or so and you may not be able to continue on in that capacity and may have to find something else to do in 5 years if you can't get your grant.

What is something that you hope to see in the future of music cognition research?

Summarized Response: Well, I think for music cognition research there's just so many things. With respect to pitch, which of course is the foundation for both melody and harmony, there is historically and currently still a lot of research done on pitch perception, but I think for me rhythm would be one area that I'd like to see a lot more experiments coming out on and I guess secondarily I would be interested in seeing more research in the harmony realm. Another thing that I'd like to see is students, and professors in music schools getting more involved as participants in research being done by cognitive neuroscientists, because it is so relevant to us understanding talent and creativity and how it relates to neural plasticity. Another one I think is really needed, and we are not really exploring especially with what the interests of ethnomusicology experts are these days, is looking at non western listeners and trying to understand from an experimental, cognitive science, psycho-acoustic perspective, what are the universals that are independent of culture? A lot of ethnomusicology is about differences and honoring differences and promoting differences. Actually, one of the main thrusts these days in power structures and how politics and economics influence music is trying to get away from thinking that what is similar is not interesting, and understanding that for a biologist, the universals are inherently interesting. There are a couple of studies where investigators have gone into remote villages that are barely touched by western music. It's that kind of field work, not just conveniently doing things over the internet, but actually looking at the way cultural anthropologists do their work, which is very different from the way experimental psychologists do their work, and trying to find some way to tap into and understand the universals in global music. In fact, the idea of reverse engineering the brain through music is very interesting. Frequency selectivity is a fundamental property of auditory neurons and frequency differences

and ratios are the basics of music theory, so that's probably not a coincidence. Music is basically tapping into frequency selectivity and other things that we have yet to know. I certainly would like to see more in the realm of neural coding and single-unit or multi-unit recordings. There's just a lot of fMRI which is gross anatomy and gross physiology but we don't really know how individual neurons represent the information and encode the information. That's a great area that can be expanded for music cognition research and kind of getting away from the same old "where is this? Where is that?" fMRI perspective and actually looking at what those neurons are doing and how they're representing various aspects of pitch, harmony, and rhythm. Another area that's of great interest in the clinical realm is music perception in cochlear implant patients because it turns out it's a lot easier for them to do speech recognition than it is for music to sound good. If you can make the music sound good then you've really got something. Being able to decode the speech is easy compared to doing music, so experts in cochlear implant research often regard music as that gold standard.

Dr. Tramo: Well, I think for music cognition research there's just so many many things. There's one area that reflects kind of the western biases, more work on rhythm perception and production. You'd be surprised how little there is on harmony. There's relatively little on harmony. Pitch, which of course is the foundation for both melody and harmony, there is historically and currently still a lot of research done on pitch perception, but I think for me rhythm would be one area that I'd like to see a lot more experiments coming out on and I guess secondarily would be in the harmony realm. One of the things that, another thing that's really wide open is, you really need to work in the arts in order to study talent and creativity, so if you're interested in music that becomes an avenue for you to pursue research on creativity. I mean you could ask a lot of questions about talent and learning, people who are taking lessons. So one of the areas that i've talked to Frank Huser about who is the education professor at UCLA music is what happens to the brain in a music student when they take their harmonic analysis class from day 1 to the final day of class. So one thing that I'd like to see is music schools, and students, and professors getting more involved as participants in research being done by cognitive neuroscientists, because it is so relevant to us understanding talent and creativity and then a natural part of that is plasticity. Another one I think is really needed is, and we are not really close especially with what the interests of ethnomusicology these days, is looking at non western listeners and trying to understand what are, from an experimental, cog-sci, psychoacoustic perspective, what are the universals that are independent of culture? A lot of ethnomusicology is about differences and honoring differences and promoting differences. Actually, one of the main thrusts these days in power structures and how politics and economics influence music and how music is made and what music is played and Carol and I went through that a lot of the success of the Beatles was that they were white guys who were kind of crazy

and really good at playing african american music, which the outlets wouldn't allow, many of the outlets wouldn't let us hear african americans so they were in a way part of the civil rights movement almost. They actually helped do away with segregation in concert halls, they refused to play Jacksonville stadium because it was going to be segregated and they broke the promoters, the promoters had to give into them and there was never again segregation in the american south after the Beatles did that in concert halls. Even though that's the current thrust thing at musicology research, if you're interested in the biology of music then the universality speaks to that. Why is it that every culture organizes their scales around octaves? So we know that octave equivalents as a perceptual phenomenon is a cross cultural universal which then begs the question, what's the underlying neurobiology of that. I think for your generation going forward, comparing listeners with different backgrounds, different cultures, different age groups, different genders, none of that has been done, even lefties and righties hasn't really been done systematically. Trying to get away from thinking that what is similar is not interesting, what is different is interesting. For a biologist, the universals are inherently interesting.

Brandon: I know there is a lab at Harvard that has the music IQ test and I know that there's a lot of controversy around it because it's kind of based just on western music and so that's just what I've seen other people saying about it that it is a good test for western music like people who have taken lessons in America and all that but it just wouldn't translate to other cultures.

Dr. Tramo: Yea, these internet based experiments obviously have a sampling bias. There are a couple of studies where investigators have gone into remote villages that are, well, none are really untouched anymore, but barely touched by western music. It's that kind of field work, not just conveniently doing things over the internet that actually looking at the way cultural anthropologists do their work, which is very different from the way experimental psychologists do their work, and trying to find some way to tap into and understand the universals. David Hubel once said to me when I was asking if I should say music in my grant applications, "music is what's interesting about the auditory system and it teaches us how the auditory system works." In fact, the idea of reverse engineering the brain through music, frequency selectivity is a fundamental property of auditory neurons and frequency differences and ratios are the basics of music theory so that's probably not a coincidence. Music is basically tapping into frequency selectivity and other things that we have yet to know. I think another answer to your question, Brandon, is I certainly would like to see more in the realm of neural coding and single unit or multi unit recordings. There's just a lot of fMRI which is gross anatomy and gross physiology but we don't really know how individual neurons represent the information and encode the information. Whether it's using animal models or in some places, including UCLA and UCSF by the way and UC Berkeley, recording from the brains of alert epilepsy patients in the OR or when they're being worked up for epilepsy surgery, that's a great area that can be expanded for music

cognition research and kind of getting away from the same old “where is this? Where is that?” fMRI kind of thing and actually looking at what those neurons are doing and how they’re representing various aspects of pitch harmony and rhythm.

Brandon: Yea, I know at UCSF there’s also, you talked about creativity, there’s Dr. Charles Limb doing research on spontaneous creativity so musical improvisation. I know that he has done research with famous jazz musicians where he somehow created a magnetless MIDI keyboard so that somebody could go into an fMRI machine and play back and forth with him so, he had a backing track, he had his keyboard out from where he is running the fMRI and then he had this jazz musician inside the fMRI and he had him playing a melody that he had written for him to learn before coming in and then they just improvised back and forth and what they saw was that when he was improvising, the brain actually went into a dream like state and so his inhibitions were brought down and the creativity was.. It was really interesting to see.

Dr. Tramo: Yea, I’m probably going to be in a conference with Dr. Limb this Friday and we certainly engaged him in the multi campus initiative so two things about that. One is that what was so interesting about that study was the deactivation of certain areas, that they actually seem to be inhibited. But he also showed that there are many areas that are activated so there’s this kind of balance between activation and deactivation that’s involved in the creative process and that seemed so jibe with a later study that was done at I think it was NIMH by Lou and his colleagues with rap improvisation. So they all showed some degree of deactivation within the frontal lobe along with activation. The other creativity study by Berkowitz, actually I was on his thesis committee when he did this study, that didn’t show any deactivation, it was a totally different result. So there’s like three studies that people talk about. Imagine how many studies you could do on music creativity. Another area that’s of great interest by the way in the clinical realm Charles is active in or likely to be active in is music perception in cochlear implant patients because it turns out it’s a lot easier for them to do speech recognition than it is for music to sound good. I remember Nelson Kiang at Harvard and MIT was one of my professors there saying the gold standard for hearing aids and cochlear implants is music. If you can make the music sound good then we’ve really got something. Being able to decode the speech is easy compared to doing music, so they use music as that and Dr. Limb is an otolaryngology surgeon so it’s very likely with his interests he’s working with cochlear implant patients. He’s in the ENT department at UCSF. Whereas, his colleague on the faculty here, Ed Chang, is in the neurosurgery department and he is doing multi unit recordings in human cerebral cortex and language studies. UCSF is one of the best medical schools in the world and those are two top notch researchers who are very much interested in music and language.

Brandon: For students like me and Katie, if we find a doctor, an MD, who is doing research like that, can you do research under them? Or is it kind of a different ball field?

Dr. Tramo: Well, you always send an inquiry. You would send a letter. Also Bob Knight, Robert Knight, is an MD PhD. So Chang is a neurosurgeon, Limb is an otolaryngologist, and Knight is a neurologist and he does intraoperative recordings also with patients at multiple institutions but he's based in Berkeley so the bay area has those three major players in doing intracortical recordings in humans. There's not much in old world monkeys around these days but you have three labs right there in the bay area that do them. You would basically send an email saying "I'm a UCLA student with a degree in cognitive science and if you have a music background, you don't have to have one, but if you have one say what that is, and I'm looking into developing my career on laboratory research on music cognition and I was speaking with Dr. Tramo and he mentioned all of the faculty on all the campuses that are doing music related research and he suggested I write you. I was wondering, are you hiring any research assistants and what graduate schools are you affiliated with and are you accepting graduate students to your laboratory.

As a pioneer in the field, what does it feel like to witness the advances in music cognition and neuroscience over the past 25 years?

Summarized Response:It's exciting to see. I think we always felt like it's got to be interesting. We didn't realize when we were building the field that there would be so many young people who really wanted to pursue careers in it and that's been I think the biggest blessing of trying to stick with it and develop programs has been meeting people who see that there is a lot of work to be done, but that it is something that is valuable to develop from a scientific and medical standpoint. You have to have a thick skin to work in the field like when you audition as a musician or an actor and realize that it's going to be bumpy so I think as the seniors looking at it we have the same concerns for young people going into the field that we have for ourselves: Is it sustainable? Is there going to be funding? And what do we need to do to make sure that you can get funding? I think the bottom line here is that good science does get rewarded. In the basic science arena things are a lot better now that the head of the NIH, Francis Collier, said we need more research on music. For doing cognitive neuroscience or auditory neuroscience research on music, I think that it is now, for younger generations, much more fundable than it was for our generation, but there's still the issue of the anecdotal stuff. Why do we even need to do experiments or randomized controlled trials when we have music therapy? The answer is that the one on one music therapy thing is a lot like psychotherapy in that

it depends on how good the therapist is and how good a transference the therapist makes with an individual. You've basically got a factor in there, which is the therapist, that you can't control. There are still people who would benefit from music therapy, but it's not going to push the envelope in advocating for these things in the healthcare arena the same way randomized clinical trials would.

Dr. Tramo: Well, I mean it's exciting to see. I think we always felt like it's got to be interesting. I mean, especially for young people because young people tend to gravitate towards music. So, we always thought it was an interesting area.

We didn't realize given any sort of even small field when we were building it that there would be so many young people who really wanted to pursue careers in it and that's been I think the biggest blessing of trying to stick with it and develop programs has been seeing people like you and Katie who see that there is a lot of work to be done, that it is something that is valuable to develop from a scientific and medical standpoint. I think we always worry, I mean the nature of being a scientist like being an artist, you always worry where the funding is coming from. It's like your parents. We worry "is it sustainable?" Given everything that we've gone through, it looks successful on paper but for every grant that you got, you didn't get 5.

You have to have a thick skin like when you audition as a musician or an actor and realize that it's going to be bumpy so I think as the seniors looking at it we have the same concerns for everyone that we have for ourselves: Is it sustainable? Is there going to be funding? And what do we need to do to make sure that you can get funding? I think the bottom line here is that good science does get rewarded. In the early years, we had a lot of trouble because people were biased and said "oh working on music is fluffy."

I don't think we have that problem anymore, at least not in science. But there's still the issue of the anecdotal stuff. Why do we even need to do experiments or randomized controlled trials? We have music therapy, why do we even need to do that? We do face those questions sometimes. The answer is well, the one on one music therapy thing is a lot like psychotherapy. Again it's hard to do those experiments, a lot of it depends on how good the therapist is and how good a transference the therapist makes with an individual.

So, you've basically got a factor in there, which is the therapist, that you can't control. So there's a place for it even though you don't have randomized controlled trials, there are still people who would benefit from it, but it's not going to push the envelope into the next level where there's a lot more institutional support for doing these things in the healthcare arena.

I think in the basic science arena things are a lot better now that the head of the NIH, Francis Collier, said we need more research on music. The NEA has an initiative for doing research on music. I just interviewed for the NSF program directorship in cognitive neuroscience, which if they offer it I don't think I'm going to do, but they knew before they invited me what my agenda would be if I were the program director. I think for doing cognitive neuroscience or auditory neuroscience research on music, I think that is now for your generation much more fundable than it was for our generation.

Can you tell us about the Institute for Music and Brain Science?

Summarized Response: The Institute for Music and Brain Science was founded in the early 2000s and the motivation there was one, getting support for randomized controlled clinical trials and two, having some freedom to do research on how the brain works as it pertains to music in the post 9/11 era when, with the funding constraints, everything had to be more directly disease-oriented. So, we had an auditory neuroscience initiative and a cognitive neuroscience initiative along with the health and medicine initiative and we were able to raise money to do experiments that we otherwise wouldn't have been able to do if we had had to go through the

federal funding system. We also did some non-empirical ad hoc work, some of which has been going on at UCLA with the mind and music program. For example, we sponsored a summer concert series for in-patients on Saturdays. And then we have an educational mission, that we can be doing a lot more in teaching young people how to read and how to do math by making video games that are fun. It's kind of this whole thing about "what is so bad about fun?" Why isn't it a fun part of education or healthcare? Why can't we make it more fun? And that is the foundation for the concept of edu-tainment.

Dr. Tramo: We were founded in the early 2000s and the motivation there was one, as I had mentioned, getting support for randomized controlled clinical trials and two was to have some freedom to do research on how the brain works as it pertains to music in the post 9/11 era when, with the funding constraints, everything had to be more directly disease-oriented. So we had an auditory neuroscience initiative and a cognitive neuroscience initiative along with the health and medicine initiative that we were able to raise money to do experiments that we otherwise wouldn't have been able to do if we had had to go through the federal funding system.

We also did some non-empirical ad hoc work, some of that's been going on at UCLA with the mind and music program. For example, we sponsored a summer concert series for in-patients on Saturdays. A lot of patients get discharged on Friday and Saturday morning and if you're left behind it's very depressing and the staff doesn't like to be there on the weekends either by the way. So we partnered with a nonprofit group of Harvard undergraduate students actually had a mission to go out to perform at nursing homes, so we partnered with them, go them all TB tested, followed all the right rules, and human resources and staffing in the volunteer department so that they would actually go up into the hospital wards at the nurse's station and set up to perform music for 20 to 40 minutes. Some patients don't want to leave their room or even get out of bed and now it's a big plus we have testimonials from them.

There's an example of something that really isn't scientific but ad hoc and anecdotal that we would like to turn into patient satisfaction data in a real study. And then we have an educational mission, you probably know about the concept of edutainment, that we can be doing a lot more teaching young people how to read and how to do math by making video games that are more fun. It's kind of this whole thing about "what is so bad about fun?" Why isn't it a fun part of education or healthcare? Why can't we make it more fun?

Bernie Kraust who is one of the founding members and has a very interesting biography and a Ph.D. in bioacoustics is very concerned about the natural sound environment. I would recommend his book, The Great Animal Orchestra, which was a big hit on the New York Times bestseller list on how important it is to soundscape our environments, our auditory environments, to optimize mental health and improve anxiety and hospitalizations and really preserve the natural world around us, which is one of the sources that humans have used to make music.

Brandon: It sounds like you guys have some good stuff going on now as well with the mindful music. Is that a club at UCLA?

Dr. Tramo: Mindful Music grew out of the Semel Institute and the Semel's interest in music. One of Semel's administrators, Delilah, is a pianist, so she has been exploring performances in Reagan UCLA medical center and hospital for the benefit of patients.

Can you describe the path that you took to get where you are today?

Summarized Response: As you would imagine, I was a musician way before I went to medical school. I started writing songs towards the end of elementary school, wrote and recorded a rock musical in high school, and ended up going to Yale in part because of its music school and drama school. I had to make a decision towards the end of med school whether I would accept the position in the neurology residency at Cornell medical college of Manhattan or continue to audition for RCA who was asking for more material. Happily, I think in retrospect, I took my neurology residency at Cornell, which was very fortuitous. At Cornell, Fred Plum, who was an absolutely fantastic neurologist, had started four divisions that were research-oriented, pretty much ahead of the neurology department's time, and one of them was a division of cognitive neuroscience that he created by bringing in Mike Gazzaniga, who is widely recognized as one of the pioneers of cognitive neuroscience. In his program project, he had an auditory section and there was an assistant professor he was working with at the time, John Sides, who was using the dichotic listening technique which is pretty much what psychologists were using before the brain imaging days to look at hemispheric differences in auditory perception. At that time I was still making demos and was in a Tribeca recording studio in manhattan and all of a sudden I

saw these keyboards with equipment and floppies and it was right when MIDI came out. I had just been reading about how supposedly timbre perception was a right hemisphere function based on one study in epilepsy patients who had had temporal lobectomies. I heard the stimuli that were used in that experiment that sounded basically like foghorns and I thought this is not what musicians think of as timbre. We think of it as a distinctive tonal quality of sound, not some sound that we have no familiarity with. So I convinced Mike that because the auditory system crosses multiple times in the brainstem, that doing dichotic listening studies really was not the way to go because it was fraught with potential errors and that was turning out to be true. So I convinced Mike that we could use the same paradigm he was using for touch perception and visual perception and play these different instrument sounds and see if each hemisphere could match a picture to the sound. and it worked. We showed that both hemispheres were actually able to perform the task, the left hemisphere had a slight advantage over the right hemisphere, and that timbre perception was not strictly a right hemisphere function and then we did the actual experiment that Brenda Milner had done with our patients and showed that for unfamiliar sounds, like the seashore timbre sounds, the right hemisphere was actually the only hemisphere that could do the task, which in the world of split brain, any time you get the right hemisphere better than the left it's always like a home run. And so that's how I got my research career started. There was a lot of pressure actually to go into areas of clinical neurology like basic research in Alzheimer's disease or develop a clinic as opposed to doing something as outrageous as going to work on music and the brain in the 1980s. But basically there were three of us in the early years of the field, two of whom now run the BRAHMS institute up in Montreal, Isabelle Peretz and Robert Zatorre, and we are all about the same age. We just pressed on and told our chairs as we were growing up this was something that was important to study and we of course had to succeed in getting funding for the research that we were planning to do and fortunately for me, being in the program project with an established world-renowned neuroscientist like Mike Gazzaniga, was a big help in me getting my first grant to be able to do this kind of research. So it was totally logical and planned in the sense that I was seeing all these neurological patients and I wondered why there is so little in the literature about music perception and so much about language. That led to the following thought processes of how do you do an experiment? How would you go about actually having a testable hypothesis that you can design an experiment to test in a laboratory? And that's a big step and something that is important to do basic laboratory research.

Dr. Tramo: That's a terrific question, Brandon. As you would imagine, I was a musician way before I went to med school. I started writing songs towards the end of elementary school, wrote and recorded a rock musical in high school, and ended up going to Yale in part because of its music school and drama school. I did spend a lot of time in undergraduate school, probably

more time than an undergraduate pre-med should, writing songs for and playing in a rock band, we ultimately called ourselves “Men with Tales.” That’s exactly what we wanted out of that, that pun intended. We got close to getting signed, first by Columbia records, and second by RCA, pretty much as a studio band, we weren't playing out in New York City. I had to make a decision towards the end of med school whether I would accept the position in the neurology residency at Cornell medical college of Manhattan or continue to audition for RCA who was asking for more material.

Happily, I think in retrospect, maybe not so much at the time, I made mom happy and took my neurology residency at Cornell, which was very fortuitous and I think for the young people out there who are interested in this area, to keep in mind that often things will happen in the course of career development that you don’t plan for. I think that’s more the rule than the exception actually. At Cornell, Fred Plum, who was an absolutely fantastic neurologist, it was really a privilege to train under Fred, he had started four divisions that were research-oriented, pretty much ahead of the neurology department’s time, and one of them was a division of cognitive neuroscience that he created by bringing in Mike Gazzaniga, who is widely recognized as one of the pioneers of cognitive neuroscience, you have the first NIH program project grant in cognitive neuroscience, he had become quite famous in his research with split-brain experiments examining the left hemisphere and the right hemisphere separately in patients who had them disconnected in order to help control their epilepsy, and Mike is still a professor at UC Santa Barbara and a member of our advisory board at the institute, a real intellectual force and taught me a lot about intellectual curiosity and pursuing things that interested me. In his program project, he had an auditory section and there was an assistant professor he was working with at the time, John Sides, who was using the dichotic listening technique which is pretty much what psychologists were using in the pre brain imaging days to look at hemispheric differences in auditory perception. At that time I was still making demos and was in a Tribeca recording studio in manhattan and all of a sudden I saw these keyboards with equipment and floppies and it was right when MIDI came out, musical instrument digital interface, and it was one of those things where “oh wow I can put a string quartet in my song now without having to try to find people and teach then what to play, I can just play it on the keyboard” of course it doesn’t sound as good but I could do that and I had just been reading about how supposedly timbre perception was a right hemisphere function based on one study in epilepsy patients who had had temporal lobectomies. I heard the stimuli that were used in that experiment that sounded basically like foghorns and I thought this is not what musicians think of as timbre. We think of it as a distinctive tonal quality of sound, not some sound that we have no familiarity with. So I convinced Mike that because the auditory system crosses multiple times in the brainstem, that doing dichotic listening studies really was not the way to go, it was fraught with potential

errors and that was turning out to be true. There are a lot of melody studies with dichotic listening and basically the results are all over the place. So I convinced Mike that we could use the same paradigm he was using for touch perception and visual perception and play these different instrument sounds and see if each hemisphere could match a picture to the sound. So it was a match to sample visual auditory multimodal integration task, and it worked, and we showed that both hemispheres were actually able to perform the task, the left hemisphere had a slight advantage over the right hemisphere, and that timbre perception was not strictly a right hemisphere function and then we did the actual experiment that Brenda Milner had done with our patients and showed that for unfamiliar sounds, like the seashore timbre sounds, the right hemisphere was actually the only hemisphere that could do the task, which in the world of split brain, any time you get the right hemisphere better than the left it's always like a home run. That's called a double dissociation where you show an advantage in one hemisphere for one type of task and the other for a related type of task and that's really what got me going but I think there's no way that if I hadn't been in the studio still making demos that I would have come across MIDI and known how to put together a MIDI system so that we could do experiments with split brain patients on music perception, and the core of the interest had come from classical neurology where I had learned that you could have a legion like a stroke or a tumor involving the left hemisphere auditory cortex and not be able to understand speech yet have no hearing loss whatsoever. So that immediately raised the question in my mind: They can understand speech, but they can hear well. What about music? And so that's how I got my research career started. There was a lot of pressure actually to go into areas of clinical neurology like basic research in Alzheimer's disease or develop a clinic as opposed to doing something as outrageous as think that you were going to work on music and the brain in the 1980s. But basically there were three of us who pressed on, two of the now run the BRAHMS institute up in Montreal, Isabelle Peretz and Robert Zatorre, and we are all about the same age and we just pressed on and told our chairs as we were growing up this was something that was important to study and we of course had to succeed in getting funding for the research that we were planning to do and fortunately for me, being in the program project with an established world-renowned neuroscientist like Mike Gazzaniga, was a big help in me getting my first grant to be able to do this kind of research. So totally planned in the sense that I'm seeing all these neurological patients and I wonder what happens with music perception, why is there so little in the literature about that and so much about language? To now, let me see, how do you do an experiment? How would you go about in a laboratory actually having a testable hypothesis that you can design an experiment to test? And that's a big step and something that is important to do basic laboratory research to understand how to do an experiment.

You are also the co-director of the University of California Multi-Campus Music Research Initiative. What have you and your fellow researchers been studying over the past few years, and is this initiative still active?

Summarized Response: The initiative is active within a number of the laboratories of the co-directors at this point. So three of the co-directors are located at probably the most active of the locations currently, UC San Diego, where there are two laboratories. One is the Swartz Center for Computational Neuroscience, where Scott McKay, who is the principal on our initiative, and John Iverson who I mentioned earlier, do research mostly looking at EEG and brain body interfaces. Sarah Creel is at UCSD in the Cognitive Science department and she works on developmental psychology. She is interested in music and cognitive development. Peter Genatta at UC Davis Psychology, who has been around forever, like Isabelle, Robert, and I, is a superb fMRI experimenter. He is published in ERPs and he is particularly interested in music and memory. Julene Johnson is at UCSF in the nursing school and is working with Peter Genatta on a grant looking at memory and Alzheimer's disease. Certainly Julene would be someone for Music Mends Minds to talk with about her program. She has a grant from the National Institute of Aging, and it's looking at singing in nursing homes and quality of life measures, so she would be the more geriatric specialist among the co-directors. Ramesh Balasubramaniam is the head of neuroscience at UC Merced and he, like Dr. Iverson, is interested in sensory-motor integration and rhythm. Of course, both of them are drummers, so they're very interested in how the auditory system, the kinesthetic system, and the movement system all work in concert during rhythm generation and music performance. It's really their basic science protocols that we would try to incorporate if we were to do clinical trials with Parkinson's patients.

Dr Tramo: The initiative is active within a number of the laboratories of the co-directors at this point. So three of the co-directors are located at probably the most active of the locations currently, UC San Diego, where there are two laboratories. One is the Swartz Center for Computational Neuroscience, where Scott McKay, who is the principal on our initiative, and John Iverson who I mentioned earlier, do research mostly looking at EEG and brain body interfaces. Sarah Creel is at UCSD in the Cognitive Science department and she works on developmental psychology. She is interested in music and cognitive development. So those are three active individuals. At UC Davis is Peter Genatta who has been around forever, like Isabelle and Robert and I. Peter is a superb fMRI experimenter, he is published in ERPs. He is particularly interested in music and memory. Julene Johnson is at UCSF, I think her home school there is the nursing school, Peter at UC Davis is in Psychology. They're actually on a grant together looking at memory and Alzheimer's disease and certainly Julene would be

someone for Music Mends Minds to talk with about her program, she has a grant from the National Institute of Aging, and it's looking at singing, I believe it's singing in nursing homes and quality of life measures, so Julene is actively doing research with the population that Music Mends Minds is devoted to, so she would be the more geriatric specialist among the co-directors. Ramesh Balasubramaniam is the head of neuroscience at UC Merced and he, like Dr. Iverson, is interested in sensory-motor integration and rhythm. Of course, both of them are drummers, so they're very interested in how the auditory system, the kinesthetic system, and the movement system all work in concert during rhythm generation and music performance. I know that Ramesh and John for example, if we were to do clinical trials with parkinson's patients, it's really their basic science protocols that we would try to incorporate into the clinical trials and what they have been doing on sensory-motor integration at the basic neuroscience level.

The popular media is notorious for oversimplifying scientific findings. What are some common misconceptions that you've come across in the media that you would like to debunk?

Summarized Response: That music is a right hemisphere function. It involves both hemispheres and there's no music center in the brain. It's really a network of widely distributed collections of neurons that participate in music cognition.

Dr. Tramo: That music is a right hemisphere function. It involves both hemispheres. And there's no center, there's no music center in the brain, it's really a network of widely distributed collections of neurons that participate in music cognition.

How are dementia patients and other patients facing neurodegenerative disease able to remember songs of their past?

Summarized Response: There's something in the amnesia literature called Ribot's law, whereby when you have something like a traumatic brain injury, you have a period of anterograde amnesia, which affects memories that are encoded after the head trauma, and then you have a period of retrograde amnesia, which impact memories encoded before the trauma. It's well known in clinical neurology that the more recent memories are lost more easily than the remote memories. So, if we can apply a model that's based more on an acute brain injury to something that has to do with a chronic progressive brain injury like Alzheimer's disease, then it appears to be the case that older memories are better preserved than more recent memories. A second factor is part of having a good memory is forgetting a lot of stuff, you have to be selective about what you remember, and one way the brain has done this is if there's an emotional impact of an

event or an emotion tied to an event it will be remembered better than if there's no emotional tag. The current understanding is with declarative memory and episodic memory, which are mostly verbal based memories when people talk about them, we know that the hippocampal system is the most important in that aspect of memory. However, when you combine an emotional tag with some episodic event, the amygdala gets involved, and the amygdala is also in the medial temporal cortex and it works in synergy with the hippocampus to encode and consolidate that memory so you can later retrieve that memory from storage. That's a second reason that it may be the case that music is better preserved as you are older.

Dr. Tramo: So there's something in the amnesia literature called Ribot's law, whereby when you have, and usually the model is traumatic brain injury, you have a period of anterograde amnesia which is after the head trauma, and then you have a period of retrograde amnesia, for before the head trauma. It's well known in clinical neurology that the more recent memories are lost more easily than the remote memories. So, if we can apply a model that's based more on an acute brain injury to something that has to do with a chronic progressive brain injury like Alzheimer's disease, then it appears to be the case that older memories are better preserved than more recent memories. A second factor is that the memories that we do retain, I mean part of having a good memory is forgetting a lot of stuff, you have to be selective about what you remember, and one way the brain has done this is if there's an emotional impact of an event and there's an emotion tied to an event it will be remembered better than if there's no emotional tag, and the current understanding is, although we think of in declarative memory and episodic memory, which are kind of mostly verbal based memories when people talk about them, we know that the hippocampal system is the most important in that aspect of memory, but when you combine an emotional event with some episodic event, the amygdala gets involved, and the amygdala is also in the medial temporal cortex, and it works in synergy with the hippocampus to encode and consolidate that memory so that later you can then retrieve that memory from storage. So that's a second reason that it may be the case that music is better preserved as you are older.

For the members at Music Mends Minds, they are not only playing songs that they have heard in the past and that they have known for years, they are also learning new songs as well. How would you say that playing an instrument is different from simply listening to music from the past?

Summarized Response: The memory literature emphasizes that there is no singular aspect of memory. It's much like emotion. We use the word emotion, but when you actually do research on emotion, there is no "emotion." It's either fear or anger or joy and they all involve different

parts of the brain so there's no one part of the brain or even one function that you can think of as just being emotion. For memory, a lot of the research points to the idea that so-called procedural memory (or muscle/motor memory) is stored in a different part of the brain than episodic declarative memory, which is what bothers my Alzheimer's and Parkinson's patients the most. It is often the first thing they notice, that they have trouble coming up with names, which the literature shows is not that unusual by the time you're in your mid 60s. The ability for the Music Mends Minds musicians to be able to learn new music is built up from the idea that they are not just learning this sound, they are learning how to make the sound. They're encoding the music , at least in part, in procedural memory and in so doing they are also drawing on motor skills that they developed and repeated. I think that's another aspect of why remote memories like musical memories in Alzheimer's patients are relatively preserved is they are "overlearned." In other words, you have heard that song over and over again your whole life. It may not be that often, but it has made its appearance in your experience repeatedly over the course of your lifetime. So what I think is happening with the Music Mends Minds patients is that a lot of the encoding and storage is done in terms of procedural memory and when they are recalling it, they have that to facilitate the retrieval of the memories and they're not just doing it auditorily like trying to remember a new melody.

Dr. Tramo: The memory literature emphasizes that there is no one memory. It's like what you'll do when you talk about emotion. We use the word emotion, but when you actually do research on emotion, there is no "emotion." It's either fear or anger or joy and they all involve different parts of the brain so there's no one part of the brain or even one function that you can think of as just being emotion. So for memory, a lot of the research has pointed out and you know patient HM who didn't have a hippocampus on either side was one of the original experimental subjects to really teach us this, is that so called procedural memory which the lay press called muscle memory, or maybe more simply, motor memory, that that is stored in a different part of the brain than episodic declarative memory like when you need to come up with a name, which is the thing that bothers my alzheimer's and PIC patients the most, and parkinson's patients, is the first thing they notice is they have trouble coming up with names, which by the way, by the time you're in your mid 60s, is not that unusual the literature shows. So the ability for the Music Mends Minds musicians to be able to learn new music is built up from the idea that they are not just learning this sound, they are learning how to make the sound. So they're encoding the music in procedural memory, at least in part, and in so doing they are also drawing on motor skills that they developed and that are overlearned. I think that's another aspect of why remote memories like musical memories in alzheimer's patients are relatively preserved is they are "overlearned" in other words, you have heard that song over and over and over again your whole life. It may not be that often but it has made its appearance in your experience repeatedly

over the course of your lifetime. So what I think is happening with the Music Mends Minds patients is that a lot of the encoding and storage is done in terms of procedural memory so that when they are recalling it, they have that to facilitate the retrieval of the memories and they're not just doing it auditorily like trying to remember a new melody.

What would you suggest to students who are interested in conducting music cognition research?

Summarized Response: I would say take all your basic science courses, you need those basic skills, those laboratory skills, you need to have a good foundation in neurophysiology and neuroanatomy, and I think maybe something that's not appreciated is understanding experimental psychology. In particular, you should know how to do an experiment in the tradition of experimental psychology. So that means usually, in addition to taking the required courses, you should get involved in some level of research in a lab that is doing something that is relevant to what you are interested in. Just seeing how a good psychologist does a good experiment, which you'll learn by reading the journals but also watching people do it, is really an essential component to developing the skill set that you need. You don't need to do too much before going to graduate school. You just need some exposure and you need your basic science courses. I think of all the things, as I've shared with my students, I would emphasize that if you think you are going to pursue a career in science and do research, especially if it is going to be in the realm of cognition, learn how to program. Currently MatLab and Python are languages that are in widespread use in the laboratories that do this brand of research. One of the reasons I did my physician scientist award as graduate school was so I could take computer programming and acoustics courses that I didn't have in my medical training. Even though I wouldn't necessarily do the programming eventually, I would know how to do the programming and how to talk to a programmer about what I needed to do to set up for data collection, for stimulus synthesis and calibration, and for data analysis. If you just know how to formulate the setup of the program, maybe not write all of the code, but really understand what needs to be done, you would have a leg up walking into graduate school that way. Another thing to mention for your audience is the society for music perception and cognition, which was really a fledgling society in the 90s but really has grown enormously and has regular conferences around the world. Those conferences are helpful if you want to figure out, what are the experts doing here? Is that the kind of research I want to do? I would encourage anyone who is thinking about graduate school to go to the society for music perception and cognition conferences and see what is out there. Conferences are how you get to meet people so you'll find a lot of warm reception at those events. You also get to talk to graduate students and sometimes you really get the inside scoop from their scoop on what they went through to get there, even more so than someone like me who isn't in the same environment as you are now. We have a number of the

professional organizations that exist on the Institute of Music and Brain Science education site. It may be the case that you would want to belong to a few, like society for neuroscience and the acoustical society of america. There are also people on campus at UCLA that are actively conducting research that you could approach like Marco Iacoboni, Martin Monti, and Greg Bryant.

Dr. Tramo: I would say take all your basic science courses, you need those basic skills, those laboratory skills, you need to have a good foundation in neurophysiology and neuroanatomy, and I think maybe something that's not appreciated- experimental psychology. I mean yes, psychology as a subject, but in particular, how to do an experiment in the tradition of experimental psychology. I mean, I've been through all my neurology training and was board eligible but I learned how to do an experiment from Mike Gazzaniga and assistant professors after I finished training. So that means usually, in addition to taking the courses, to get involved in some level of research in a lab that is doing something that is relevant to what you are interested in. I think there are a lot more opportunities now, I remember there was not even cognitive neuroscience when I was in college. Gazzaniga started that with George Miller in the 70s. Just seeing how a good psychologist does a good experiment, which you'll learn by reading the journals but also watching people do it, is really an essential component to developing the skill set that you need. You don't need to do too much before going to graduate school. You just need some exposure and you need your basic science courses. I think of all the things, as I've shared with my students is that, if you think you are going to pursue a career in science and do research, especially if it is going to be in the realm of cognition, learn how to program. Currently matlab and python are languages that are in widespread use in the laboratories that do this brand of research and it really, and one of the reasons I did my physician scientist award as graduate school was so I could take computer programming and acoustics courses that I didn't have in my medical training. And even though I wouldn't necessarily do the programming eventually, I would know how to do the programming and how to talk to a programmer about what I needed to do. That was essential for me to get any experiment done. I needed to know how to write code. I needed it to set up for data collection, I needed it for stimulus synthesis and calibration, and I needed it for data analysis. So, it's a little bit difficult for many students to fit in, especially because they are hard computer science classes, but I would strongly recommend anyone who is thinking about going to graduate school and doing experiments that involve experimental psychology or any kind of acoustics to at least take one course in C++ or MatLab or Python so that you can at least understand how to set up your experiments and how to analyze data using a programming language. I wouldn't say C or any of the ones that are kind of difficult, I think C is the one I had to learn that's rarely used but pretty much MatLab is the widespread one and because MatLab is expensive, it's great, but because it's expensive a lot of the students have been using python I understand because it is

freeware. I don't know that it has the toolboxes like MatLab does which is important for auditory work because they have the signal processing toolbox, or if you're doing fMRI work, to have an imaging toolbox. But still, if you just know how to formulate the setup of the program, maybe not write all of the code, but really understand what needs to be done, you would have a leg up walking into graduate school that way. I would also encourage all the UC kids to be in touch with all of the individuals on UC MERCI. That's why it exists, to give you an opportunity to communicate with some of us and maybe get some leads about what research you could get involved with.

Brandon: I think that is something I really appreciate about the cognitive science major is that I got a good understanding of psychology and neuroscience and computer science because, we aren't computer science majors so we are not learning front to back how to program everything you need to know, but we got, like, I took an intro to MatLab, Python, HTML, and C++ and like I said I don't think I could go and get a job as a straight coder but just having the basics and understanding all of those has been really helpful in just talking to other people about that type of stuff and in research it has been helpful as well.

Dr. Tramo: Good. And that was through the psychology department at UCLA?

Brandon: Yea.

Dr. Tramo: Yea, I know Peter Genatta at UC Davis teaches a MatLab course. So it was great that the psychology departments are doing that.

Brandon: Yea, I have actually met Peter Genata at an APS conference, it was in San Francisco in 2017 I believe and there was a symposium on the cognitive neuroscience of music and so that was really cool for me to go and hear and go up and talk to him afterwards. Super nice guy.

Dr. Tramo: Well, I would encourage all the UC kids to be in touch with all of the individuals on UC MERCI. That's why it exists, to give you an opportunity to communicate with some of us and maybe get some leads about what research you could get involved with. It is a little tough for faculty with undergraduates because you can always spend usually a couple of weeks or a couple of months maybe in the summer and then maybe ten to fifteen hours a week so a lot of faculty think, well the amount of time I put into an undergraduate student, there's not a lot that actually gets done. It's more of a time sink than productive but I would still encourage you to try to do that and if anything it's a way to figure out how you are going to do graduate school. Another thing to mention for your audience is the society for music perception and cognition, which was really a fledgling society in the 90s but really has grown enormously and has regular

conferences around the world, it is an international society, so some of them are outside the United States. We have on the institute education site, a number of the professional organizations that exist, it may be the case that you would want to belong to a few, like society for neuroscience, the acoustical society of america, I belong to those and that was sort of, it wouldn't really have very much on music and science and still really don't, although the acoustical society historically has made major contributions in music perceptions, but now the society for music perception and cognition has really grown. Those conferences for young people would, kind of, everyone is there showing their wares. So, if you want to figure out, what are they doing here? Or what are they doing there? Is that the kind of research I want to do? Oh, that's not interesting. I don't think I want to do that stuff. So, I would encourage anyone who is thinking about graduate school to go to the society for music perception and cognition conferences and see what is out there.

Brandon: Yea, and I was actually on their email list as a member. I wasn't able to go to any of the conferences, but just receiving the emails, seeing what positions are open- a lot of them are too far ahead for me because they are like professorships and post docs- but just seeing what's out there is super motivating and exciting to see that there is so much going on, even though it seems like such a small group of researchers who are conducting research on this.

Dr. Tramo: Yea, conferences are how you get to meet people. You know, you introduce yourself and say Oh I'm a student at UCLA, I was a cognitive science major, I'm interested in the field, and you know we're always, like your question implied, we are really excited about young people who want to go into the field. So, you'll find a lot of warm reception at those events. And you have them captive with the posters, you have to stand at your poster. And you know what else you have there, you get to talk to graduate students. So, it's sometimes you really get the inside scoop from their scoop on what they went through to get there and how they found it and what do they wish, even more so than someone like me who isn't in the same environment as you are now, what was it like for them is more contemporary. But I think at UCLA, Marco Iacoboni, who is in psychiatry at the Semel Institute, is actively doing research with fMRI and transcranial magnetic stimulation and very much interested in music and social neuroscience aspects of music and Martin Monti, in Psychology, and Marco is on our board at the Institute, and Martin Monti in Psychology who has a wide range of interests, consciousness, language, math, but he is doing some comparative work with language, math, and music and he is an fMRI guru. So those are two people within UCLA who are actively wanting to do experiments on music. Greg Bryant in Communications studies, works on vocalizations, non speech vocalizations, which is a wide open area, a lot more work needs to be done there. Professor Bryant has done some really interesting research, so those are three people on campus who are in the lab doing research that you could approach.

Brandon: That's something that's really interesting to me, fMRI research with music. When I was applying for jobs this past year it was a necessity to be trained in fMRI, because I was not able to learn that, I was in a cognitive psychology lab at UCLA and so I wasn't able to get that training and I got trained in December and I really love it, I love trying to learn all of the extremely hard algorithms and different ways of analyzing it, but it is really interesting research.