Interview with Dr. Nina Kraus

by Dr. Elizabeth Krasnoff of Sound-Medicine.com

Introduction

Book – *Of Sound Mind* by Dr. Nina Kraus

Dr. Elizabeth Krasnoff (00:00:14):

Hello to Dr. Nina Kraus and to our audience of sound enthusiasts. My name is Elizabeth Krasnoff, and this is my dream interview. I have a passion for researching the auditory brain, specifically the ability of sound and binaural beats to affect the human nervous system and states of consciousness. I was born half deaf, and it has influenced my life greatly. I've spent my whole life studying sound, singing, making music, healing with music, and researching sound in music. I started my own company Sound Medicine (www.sound-medicine.com) as a way to heal with music and sound, and I have been involved in every possible inquiry on the topic all the way to consciousness and states of consciousness. So you can imagine that I was thrilled to read the book *Of Sound Mind* by Dr. Nina Kraus. As soon as I read it I decided to interview Dr. Kraus about this incredible book that is really at the forefront of the field of auditory brain research.

Unknown
Field Code Changed

Elizabeth (00:01:50):

Dr. Kraus has her own lab, Brainvolts (access@ brainvolts.northwestern.edu), to see the dozens of experiments over decades that she has conducted in the field of hearing. She has many focuses to her work, several of which are particularly interesting to me. Especially her ability to use the results of her experiments to understand how to help children who have grown up in impoverished environments. Believe it or not, there's a connection between childhood environment, hearing, and the auditory brain. So we're going to learn about that today and also ask about binaural beats. I am going to ask her to break down some categories for you. One of the most impressive things about this book is that Dr. Kraus takes this vast thing, the auditory hearing brain, and puts it into neat categories that we can understand. So we're going start by talking about some of those categories and some of the sound ingredients, which will lead us to understanding her work. Nina, you write that you can summarize your career in the sentence, that the sounds of our life shape our brains. Can you tell us a little more about your inspiration for writing this book *Of Sound Mind*?

Dr. Nina Kraus (00:03:31):

Well, I love sound and the brain that makes sense of it. I'm a biologist. So that's my perspective. And if you go to our website, our homepage shows that we research music, rhythm, aging, concussion, language, bilingualism, reading. And you might wonder, why are they even doing at Brain Vaults? And it's all under the umbrella of sound and the brain, which of course includes our body as well. That we, our heart and our lungs and our guts – this is our whole system. And I realized that I wanted to put this information out because it really does hold together. I wanted to put it all in one place because, I speak to people who are interested in autism or dyslexia or music and they have their particular perspective. But in fact, there is a holistic perspective.

Nina (00:04:50):

There are so many different ways that sound interfaces with our personal lives. And I wanted to put this information together there in a way that would make sense as a whole so that people would get something out of it, no matter how much they know about the topic, so that it's accessible. There's something just very remarkable about sound, which you and I are experiencing right now. You know, there is what Ian McGilchrist calls reverberation, this back and forth that happens when we are communicating through sound. Because sound is alive. And we have an idea about the topics we want to talk about, but we don't have a script. There is this back and forth that enables us to connect. And one of the biggest messages, the biggest theme in my book is that sound connects us to each other and connects us to our environment. It's this very important force that should be honored.

Elizabeth (00:06:24):

The expression came to my mind as you were just talking is the improvised life that you talk about in your book.

Nina (00:06:35):

We are everyday improvisers when we speak, and that's incredible.

Elizabeth (00:06:43):

Yeah.

Nina (00:06:44):

And it's so present, it's so alive and it's so underrated.

Hearing as a Complex Function

Elizabeth (00:06:49):

Why do you think, and you talk about this in your book, that sight and smell are designed more simply and hearing is a far more complex operation?

Nina (00:07:02):

I wouldn't say simply, I would just say differently. And you know, regarding our evolutionary origins, sound is a very ancient sense that evolved from our positional sense. We know that our balance and our hearing organs are encased in some of the same structures and they have some of the same properties that hair cells have that move with vibration. Whether the vibration happens through the bone or starts somewhere else we originally began as aquatic creatures. And so the vibration was the vibration of water. And then as we became land animals, we had to be able to hear the vibration and the movement of air molecules instead of fluids and the air molecules using our organ of hearing.

Nina (00:08:40):

One of the ways that we hear is through the cochlea, which is our inner ear which looks like a snail. And sound vibrations have to vibrate, to move those hair cells that are encased in fluid. One of the things that happened as we moved from sea to land is that there is a poor match between the movement of air molecules and the vibrating fluid in which the cochlea sits. And so that's where we developed a middle ear, which is a way of amplifying the frequencies that are especially important for humans. But I think more fundamentally, whether you are a land or a sea animal, is that vibration will cue you for very basic survival needs. So for example, this sound that I hear, or is it going to eat me? Can I eat it? Can, can I mate with it? Or, oh, I heard that sound before, and that's bad news. I'm outta here. So our information that we get about vibration is absolutely fundamental to survival, and has been so since our beginning as organisms.

Elizabeth (00:10:52):

So I just want to jump in here for a second and ask you to break something down for the audience. The auditory brain visits many regions in the brain as it's working, and you have defined those four major regions as the reward center, the cognitive center, the sensory brain, and the motor brain. So could you talk about that a little and explain the significance of engaging all four of those sections of the brain?

Nina (00:11:26):

Thank you. The hearing brain is vast, and you're right. Most people just think, oh, it's just the ear. But no, the hearing brain engages our cognitive sensory motor and reward networks. So let's unpack this, our hearing brain engages with what we know, what we remember, what we pay attention to. So our hearing brain very much engages – and it's a back and forth by the way. I like to think of the brain more as a circuit with specialized nodes that is very interactive. So the hearing brain very much engages what we know, our cognitive sensory, how we pull together, what we hear with what we see and what we smell, how we experience sensations of sound. So we have to integrate the information from our other senses.

Nina (00:12:39):

And the hearing brain is very much, you know, it's right there. So our cognitive sensory motor, sound is movement. And to create sound, you have to move, and movement is such an enormous part of sound and vibration, and it engages how we move. If you just think of speaking or playing a musical instrument, while you are resolving the physical complexities of moving your voice or your fingers across a keyboard, you are listening to the sounds and you are then adjusting your movements based on what you are hearing. So your motor system is deeply involved, cognitive sensory, motor, and reward. Sound really influences and engages how we feel from the very beginning, like, oh my God, I'm afraid something is vibrating and I better get out of here.

Nina (00:13:59):

Because I remember that I had a bad experience with that sound. Or, this is a sound I really like, this is important for procreation. Or this sound was important for food. How we feel about sound is very important. So if you just think in general that our hearing brain engages our cognitive sensory motor and reward system, it engages what we know, how we feel, how we

move and how we integrate information from our other senses. That is the way the hearing brain works. And our sound mind is taking all of that information together and shaping it by our experience in the past, our experience in the present, that shapes our experience in the future.

Ingredients of Sound

Elizabeth (00:15:05):

I want to break that down a little more for our audience. One of the major things that Nina has done in her lab involves a breakthrough in how to interpret the electrical patterns in our brain. Called Frequency Following Response (FFR). Using FFR to understand the signals, the pathway flow in the brain. By using this diagnostic Nina was able to break down four sound ingredients that happen while the brain is hearing and, using these ingredients, was able to further understand what could go wrong and how we could fix it. And so there are things like FM sweeps, harmonics. Those are some of the basic sound ingredients. Nina, can you talk about those a little and why it is important to measure them?

Nina (00:16:08):

So if you think about sound you can measure a sound wave. And again, we live in this visually biased world where sound is invisible. Using vision, you can see - I have this item here, and it has a shape size, a color, and texture. These are ingredients of vision, but sound also has ingredients. Sound is invisible, but if you think for one minute, you realize there's pitch timing, timbre, loudness, phase frequency, modulation. There are many, many ingredients in sound. And so there are ingredients in the sound wave and the brain needs to make sense of these ingredients. And one of the metaphor boards that I like to use is I think of the brain as a mixing board. So think of the fades on the mixing board being tied to each one of the sound ingredients and based on your life and sound the languages you speak, the music you make and the noise you live in, these fades are going to be the relative height, or these fades are going to be in different places that will reveal your strengths and where the bottlenecks are.

Nina (00:17:27):

So, yes, we're deeply interested in using this information, to really apply it to how we think about the world and how we engage with it. For example, we've learned that the musician brain, really

strengthens the harmonics and certain aspects of timing that is very much a part of the musician signature. So if you think of harmonics, the harmonics enable us to distinguish whether it is a flute, or is it a piano playing the same note? So the pitch is the same, but this note sounds different if it's played by these two instruments, because the harmonics are different. Well, the harmonics also let us know whether saying D or G is in the harmonics.

Nina (00:18:36):

That's one of the very important cues. So these harmonics are important ingredients, important cues for music and for language. And so if you strengthen your brain's ability to make sense, to make sound, to meaning connections, to make sense between these ingredients, the sounds and various meanings, then you are strengthening your brain, not only for music, but for language. And we also know that kids who have certain language impairments have in precisely some of these ingredients, such as harmonics, the FM sweep, some aspects of timing. So making music really strengthens the brain for music and for language.

Sound and Child Development

Elizabeth (00:19:33):

What was really exciting to me about this whole line of research was the ability to study children who are raised in impoverished environments. What we have learned is that there is a specific neural signature in the auditory brains of these children. And so what you are talking about is that by understanding that these auditory brains have both a less precise processing of the sound details that come in and more static present in the brain, we can begin to understand how to correct that. Because what we're basically saying is that when you can't hear, you can't receive the signal as clearly, and there's more interference in the brain. So what does come in can't get processed. What can we do about that neural signature of poverty in terms of your research, that seems to be a signature of an impoverished environment. And the bottom line here that's so exciting is that something can be done about that. Not only have we identified what is different, we've identified what we can do. So do you want to say a little bit about what we can do?

Nina (00:21:02):

Sure. First of all, you know, that was really well put. Next time you can write the book.

Nina (00:21:13):

So, as a signature of poverty, we know that hat linguistic stimulation is very, very important to the development of the sound mind. And what's been known for a long time is that there is a relationship - it's certainly not a perfect relationship at all, but there is a relationship between maternal education and linguistic stimulation. Some of your listeners might be familiar with the 30-million-word gap, which the idea that kids whose moms have less education are likely to hear 30 million fewer words than those whose moms have more education.

Now there are many, many exceptions. But we had projects going on in gang reduction zones of the Chicago public schools and Los Angeles schools.

Nina (00:22:22):

So these were in low income areas. Most of the kids qualified for subsidized lunch, and we just divided those kids in the same classroom, same teacher, based on their mom's education, thinking that may be an index of maternal stimulation. And what we found is that the kids who have had less linguistic stimulation who had a brain where the processing of sound ingredients, linguistically deprived, have not had as much experience making sound to meaning connections. So the way that the brain now makes sense of these important ingredients that are crucial for language, that's diminished. And yes, internally the brain creates electricity all the time.

Nina (00:23:42):

So there is electricity that can be more or less synchronized. And this neural noise is excessive in the kids with linguistic deprivation. And we were wondering, might this be malleable? And can we demonstrate that? So we had some kids who were involved in music education, regular music education, and other kids who were involved in other enrichment activities. And what we found is that the kids who were engaged in regular music education, these particular sound ingredients were strengthened, and it partially offset what we call the the neural signature of poverty. We also found that speaking another language, because many of our participants were Spanish speakers. So they spoke Spanish and English and that wonderful, sound tone flexibility that they have learned by having two languages, was protective against the neural signature of poverty.

Elizabeth (00:25:03):

I just want to say that this blows me away every time I hear about it or read about it. I myself have done a pilot study in the lab, and I know how incredible it is to be able to replicate anything with any certainty let alone to be able to take the next step and say we have identified a place that is not working, and we can replicate correcting this pathway every time we do this activity. So I just want to honor all your years of hard work and dedication that have allowed us to come to some of these incredible solutions, which are non-invasive, accessible, and inexpensive. I'm really excited for the world to know about you.

Nina (00:25:59):

I think that's really a very important theme that runs through the book. The last chapter is very much a call to think about how sound matters. So let's think about the choices that we make for ourselves and for our children, the choices we make educationally, the choices we make in medicine, for healing. These are things that we have some control over in our own tiny ways. And there's a whole chapter on noise. You know, we often live in very noisy places. And there are things that we can do. There are things that we can lobby for. But because sound is invisible, we're very cavalier about it. We don't realize the important effect that noise for example, is having on our ability to think, our ability to feel, our ability to move, because remember the sound brain is vast - it includes cognitive, sensory motor, and reward processes.

Nina (00:27:24):

There have been studies showing that children who are educated in classrooms that overlook a highway learn more poorly than kids in the same school whose classroom overlooks a field.

Binaural Beats

Elizabeth (00:27:48):

I do want to mention here for the listeners that are interested in research-based solutions, that there are a lot of lists in this book that talk about where the research is and what we can do specifically. There's a list on page 167 about, music therapy, research-based music therapy solutions. I also want to mention that at the end of her book, there is a whole chapter on a call to action, and it references many of the things that we can do to nurture our sound mind, and choices we can make that we may not be aware of right now. We're going to come back to some

of those things in a bit, but I wanted to take a minute and ask a few questions about binaural beats. So what are binaural beats? This is a technology that really has come into consciousness in the last 50 years.

Elizabeth (00:28:51):

And I like to think of it as a brain hack. It falls in the category of brain hacks that we're all studying right now. How can we affect the brain into different states of consciousnesses? So binaural neural beats is a sound brain hack, and it is created by taking a tone and splitting the tone by a certain amount, a specific amount, let's say eight Hertz. Sending one signal to the left ear, say that signal is 440 Hertz, and then sending the other signal to the right ear that is 448 Hertz. So that creates a difference in the tone that your brain is processing and in the process of regulating that sound difference. We are finding that the evidence shows you can affect states of consciousness in the brain. So the one other thing that I want to say about that is that binaural beats activate your hearing pathway that we already have by normal hearing.

Elizabeth (00:30:07):

If you think of like a bat echolocation, we have the ability to locate vibrations in space and understand our relationship to them. Is it a tree falling? Do I need to get out of the way? Is it going to eat me? Am I going to mate with it? Like, what is it? We understand a lot of these things through our binaural hearing, which is essentially any sound that is not directly in front of you. If it's just a little bit off center, then we will understand it through this binaural hearing pathway. I'm a little curious, what is the difference really between the artificial binaural beats that we make in the studio and the natural binaural beats that we hear in nature all the time. Obviously they don't continue as long and as consistently in nature. So that's one difference. What else is there?

Nina (00:31:02):

Yes. You can create binaural beats. You can create binaural beats with sounds that are directly in front of you. And you can hear the beat frequency, which is the difference of these two sounds. It is part of how we hear, but you can, you can help it along and you can also be creating as I understand it, and I really don't understand a lot of this, but my understanding is that we know that there are particular rhythms in the brain and my book, I have a whole chapter on rhythms

outside the head and rhythms inside the head. So outside the head are the rhythms in the sound waves. And then we have the rhythms inside the head and our brain waves in the currency of the nervous system. And there are some fundamental brain rhythms, very slow ones that we have known about for a long time and probably people are familiar with alpha and theta and gamma.

Nina (00:32:22):

So these are brainwaves that are occurring below a hundred Hertz. So they're a pretty low frequency. And our brain has these rhythms, and certainly there have been associations between alpha rhythms and focus, and the Delta rhythms and theta rhythms with relaxation. And we are interactive creatures, right? And so in the same way as we can entrain with each other, when we sing, when we clap, right. When we dance, we can entrain with rhythms all around us. You can entrain your brain if you have created sounds that are matching, say a theta rhythm that you're trying to get your brain to synchronize to. You can create a set of sounds that will likely enhance those particular brain rhythms.

Elizabeth (00:33:51):

So where we are in the field right now is that there is evidence. I'm not going to say proof, but there is evidence that neural binaural beats do produce various states of consciousness in our brain, let's say relaxed, sleepy, or focused. Those are the ones that we have the most evidence for. We've also learned that there is not a strong enough for a frequency following response (FFR), not a strong enough electrical response in the brain to consider binaural beats as a form of entrainment. We have a lot of research showing that sound rhythms entrain the brain, but not binaural beats. We don't understand most of what binaural beats do right now. How do binaural beats actually affect the brain? Well, the primary hypothesis in the field, which I quite like actually, is that some of the data from the binaural beats goes into a second auditory pathway, the reticular activating system, or the RAS, which is located in your brain stem.

Elizabeth (00:35:11):

And this neural network is also responsible for our states of consciousness. It's the gateway to our states of consciousness, again, sleep or that middle state of being slightly awake, slightly asleep and wakeful. So the idea is that the neural network also takes in all of the sensory information - sight, sound, touch, smell. It’s in the thalamus, and it directs how to respond to our

environment. And I very much like your definition of the thalamus as a searchlight for consciousness. So how would you approach this? What kind of questions would the brilliant, Nina Kraus's brain ask around this topic? How do we even begin to understand what is happening here?

Information Happens Through Sound

Nina (00:36:07):

Well, I see the brain in general as an interactive circuit that affects many areas. And also there are particular hubs and nodes that we know are important for certain jobs, but they all interact with each other. And so you might think of it as a paradox, but as with many deep paradoxes, you can have two truths, you can have two things that seem to be opposing, be true. One is some specialization in the brain, in different areas. And the other is that the brain has to work all together. So you can't say that a particular function is happening here.

Nina (00:37:20):

It is both happening here. It's predominantly engaging certain mechanisms that might be happening here, but it's happening because it's attached to an entire network of brain and body. So back to the reticular activating system, you know, that Searchlight metaphor is not mine. I don't remember who came up with it. But it exists throughout the brainstem and mid brain and thalamus. It's a whole network that modulates our arousal and it's always there. It's always part of what is going on in our brain. So in the different ways that we can engage our arousal, clearly the particular formation has a role in how much we're paying attention, how drowsy we're feeling, how asleep, that and other interacting networks are part of the system.

Nina (00:38:44):

So we are deeply built to remember information that happens through sound, and we learn our ABCs that way. Some people learn the periodic tables using song. So sound is very, very sticky. And our memories for sound are very strong. And again, they come through years of experience. So, if one of my sons shows up or calls me, you know the expression, it's so good to hear the sound of your voice. Well, why is it so good to hear the sound of his voice? Because I have had

years and years of sound to meaning cognitive sensory, motor and reward interactions with him with that voice.

Elizabeth (00:39:52):

That's interesting. That's interesting to me, because one of the most successful ways I noticed in the clinical studies that I reviewed, one of the most successful ways that we measured neural beats was through functional connectivity. And that is essentially a measure of how the various pathways in the brain share electricity. So it's measuring the amount of electricity that goes between the auditory brain and the cognitive center, or the reward center, or the motor center. When is the communication lighting up? That's what functional connectivity is studying. I think you've said something really interesting here, which is, I know you talked about functional connectivity in your book, using that as a way of measuring, but what we really want to think about in the field is how to move forward from here. Our diagnostics are not accurate enough, but functional connectivity may be a way forward. There are also ways of applying diagnostic tools to EEG readings. Artificial intelligence is starting to come on the scene and give us a much more sensitive ability to interpret the EEG readings. Those are both things that I think may come forward to help us further understand what is actually going on here in these very complex systems.

Nina (00:41:33):

But you know there are many individual differences. So I think that that's one of the difficulties with some of these, with any study in science is that we look at effects that can have some statistical significant in populations of people. But then when you try to apply it to individuals, you know, individuals are not populations. And so it's, it's sometimes difficult to apply what you have learned across a lot of scenarios and a lot of different people. I mean, functional connectivity is tremendously important and, and imaging in the brain is very important.

Nina (00:42:39):

But I also think that it has the potential to mislead us because there's so much going on in the brain besides what you're measuring. And I don't really think that it is a matter of just having higher and higher resolution, because I don't think that love is happening here, or fear is happening there. This, this is an interactive system, so in some ways, by looking for where

something is happening, it's kind of back to what I was talking about earlier, this idea of, yes, there are particular areas, but they only make sense to the extent that they work together. And the final thing is that a again, while artificial intelligence and technology have a huge amount to give us, we are right now using technology to have this conversation.

Nina (00:43:47):

There are many things that I am personally grateful for. On the other hand, the common metaphor of the brain as computer is completely wrong because the brain works nothing like a computer. You know, we understand computers, but we don't understand the brain. So it's important to embrace the fact that the brain is so not understood and complex, it makes it very, very beautiful. I think that it's just wrong to make the brain computer analogy and there's a lot of, of hubris involved in thinking that.

Elizabeth (00:45:16):

I agree with what you said that the dream is to create a personalized diagnostic. One of the conclusions that I came to in my research was that we need a way that we could be with each individual, because every sound brain is different. Every individual is different. How can we create a tool to help so many individuals. I'm actually working with a group in Europe right now called WeVoice that is doing just that. It uses software delivered via smartphone. You can use biometrics to diagnose the stress levels of the individual, and the software algorithms allow you to prescribe the right kind of sonic medicine, the, the right sound medicine or playlist for that moment. That to me is an extraordinary breakthrough.

Nina (00:46:24):

Yeah. But I don't know - I would say that my primary way of making those connections is in the real world. And not through technology, I'm happy that others are working on that, but to me it happens through conversation and through music.

Elizabeth (00:46:46):

Fascinating.

Nina (00:46:48):

Interesting. You know, I really do think that our basic biological systems, we have to be careful about because we will learn - a different hearing aid will really change your relationship with, with the world. So it's going to be very important that you have a particular hearing aid and that as a sentient being really make decisions about - I've been using this for a while and, and this is just not working. I'm going to make some changes - it's something that you learn and make judgements for yourself. And again I know that there is a lot of transcranial stimulation that is used.

Nina (00:47:54):

And this is something that is very helpful in certain kinds of disorders. But I mean, I personally wouldn't even engage as an experimental subject in study because I know that our neurons operate by electricity and magnetism. That's the currency of the nervous system. You can stimulate your brain and something might happen that you might like or not but what else could be going wrong or right.

Elizabeth (00:48:43):

It's true. We don't have any level of precision yet. And any real scientist will be very clear about that.

Nina (00:48:53):

That is, I think you, you said it really perfectly. People who are exploring these domains, the really thoughtful people are really appreciating what can go right, what can go wrong and, you know, realizing that, you know, there is just not going to be an app to fix this problem in everybody.

Music and Emotion

Elizabeth (00:49:35):

You know, one thing I've always been curious about is the connection between music and emotion. So you tell us that the sound pathways are intimately connected to the reward pathways and the reward pathways are in the limbic brain, where emotion also processed. So how can we

think about that in a therapeutic sense? How can we work on our emotions through music, through sound? Are we doing that right now?

Nina (00:50:17):

Certainly we all know that music has an emotional engagement - it can be happy, it can be sad. It can produce all kinds of emotions. You know, clearly the limbic system is involved in emotion, but the fact that the limbic system is part of this whole system is I think the very important piece it isn't just music, because, you know, we all like different music. We have different memories, we have different associations and different relationships to a passage of a few notes that we're trying to learn to sing. And it's this tremendous feedback of, you know, singing, you're listening to yourself, you're feeling a certain, and my music teacher tells me Nina, if it feels good, it sounds good.

Nina (00:51:51):

I think there's a tremendous wisdom there, you know, as I'm playing whatever instrument, there is this constant connection. And so yes I do think that there is a lot of opportunity for us as a society for us as individuals, for us as parents and friends to use music for healing.

Elizabeth (00:52:25):

I have another question. I have a lot of people come to me with questions about misophonia, which is the hatred of sounds, specific sounds that make you furious and tinnitus, which is ringing in the ears. Actually I have both of those - I've collected quite a few sound issues. My question about this is, you talk in your book about how those occurrences create negative emotion and a negative emotional feedback loop starts. How would you suggest that we work on that? How do we break that negative emotional feedback loop? All of your answers so far have been about an organic systemwide response

Nina (00:53:22):

You know, what works for one person is going to not necessarily work for another person because we have different sound minds based on our biology and what has become of our biology based on our life in sound. Okay. So you had had mentioned in some correspondence that you found that many people use white noise as masks for tinnitus and also people

increasingly use it to try to keep babies from waking up from external noises. And you know, the biology speaks to me in that, we know that babies especially are, we are just amazed by how quickly they make sound connections. So their developing brain is just ready to do that. And we know in experimental animals that if you present just moderate levels of white noise to cats, for example, little kittens that the precision of the mapping of their auditory brain just becomes blunted.

Nina (00:54:47): Since there is no meaning in white noise, there is certainly meaning in masking in that for example for an adult, if you're trying to sleep, if it were me and I needed to use some kind of a masker, it would be music or nature sounds, or something that wasn't meaningless. So I think that that's important. And, and again, you know, we all make our own choices. Certainly if it was my kid, my developing kid, I would want them to learn how to soothe himself and to wake up and get himself back to sleep again, and certainly I would never use white noise. But again, that's me. And, through the knowledge that, that I have, what I call converging evidence and my own sound mind, my scientific gut feeling. I try to make choices for myself and my family and what I think we can do educationally and in medicine. And again, it also depends on the context, you know, like this child and that child.

Elizabeth (00:56:30):

As I listen to you throughout this interview, I feel that you really embody your work. You are inside your work and your work is inside of you. When you answer a question, you don't go to one specific thing, you go to the systemwide impact. It's not one thing.

Nina (00:56:56):

Thank you for that.

Elizabeth (00:57:04):

One example that I loved from your book, and this is going to be about the auditory brain motor brain connection, was that the researcher was able to create an interpersonal connection with a baby through the use of rhythm. And the way that they tested this was that if they bounced the baby on their lap in rhythm that after that the baby would be more willing to pick up a toy and

hand it to them, than the babies that had been bounced off rhythm. Pretty clever experiment. A pretty amazing response showing that rhythm creates a bond between humans.

Nina (00:57:51):

Yeah, it does. I mean, think of what happens when you dance, when you move, when you have a conversation, rhythm is, is, is tremendously binding. And sound has a lot of rhythm as it's one of the great components inherent in sound. And it is one of the ways that we can think about how sound connects us.

Elizabeth (00:58:26):

And there'll be one final question, but I just want to talk about the example of your middle son, who you wrote about in the book, that had some issues learning how to read. And you brought in all of your research and understanding of the connection between the hearing brain and reading to help your son learn how to read. And he's gone on to be quite successful. You mentioned it in the book, but I thought it would be nice if you mentioned for some of the mothers, what you did. There are many mothers that have kids who have difficulty learning how could they benefit from this information.

Nina (00:59:10):

Yeah. You know, people might say, my child has trouble reading. But what does that have to do with sound? Everything. You know, because first you learn to talk and, evolutionarily we have been communicating through voice and sound for hundreds of thousands of years. We've only been communicating in written language for 5,000 years, which is a tiny part of our history. And so we learned first as babies, we learned already in utero, we make sound to meaning connections. You learn to talk before you learn to write. And as you eventually learn to write you combine the sounds and the meanings that you already know with a symbol on the page. And so there's a lot of research, decades of research and many labs all over the world showing that there is a deep connection between auditory, the processing of sound and reading and rhythm is one of the components there too since many children who have difficulty learning to read also have some rhythmic challenges.

Conclusion

Elizabeth (01:00:33):

That's interesting. And it kind of ties into my final question to you, which is how do you see the future of sound going? Or how would you like to see it go? And by the way, for our listeners, there's a wonderful list on page 107 of the already documented ways that sound is an incredibly powerful healer, things like dementia or autism or motor or issues or stress. And you draw a really powerful connection here between sound and its influence on the way that we think or sense or feel or move. Those are the categories that you can think of sound as one of the tools in your toolkit to approach a problem that we might be having. So what would you like to see going forward in those categories?

Nina (01:01:35):

Let me just mention that since there is this long history of using sound for healing. I don't understand why sound and music in particular isn't used more in mainstream medicine. But it it's one of these things that people need to learn about, appreciate, and even just experience on their own. Like Nancy Gustafson, who is an opera singer renowned opera singer. Her mom was in an elder care facility and, and didn't even remember who Nancy was when Nancy was visiting her. And one day Nancy started playing some Christmas carols on the piano and her mom just began singing. And during that time, when they were singing back and forth, they were communicating with each other. And so this memory for sound is a portal to who we are.

Elizabeth (01:02:56):

I love that.

Nina (01:02:57):

Now Nancy Gustafson has founded an organization called Songs by Heart Foundation which is one of many organizations that increasingly are using sound to help with memory. And one of the areas that I'm especially interested in is, we do work on injury and concussion. So right now we have an NIH grant that is funding our work with all of our 500 division our big 10 athletes at Northwestern university. So we measure their brain responses to sound in the beginning and at the end of every season. And we find that if someone sustains a concussion, we can clearly see that their hearing brain is disrupted. You know, making sense of sound is one of the hardest jobs

that we ask our brain to do. If you get hit in the head, it's going to disrupt this process. It is my view that rhythm and rhythm therapies can be used. Again, this is a way in which computer music medicine can be quite helpful to help and train some of the rhythm skills that athletes are incredibly good at, just because of what they do. You know, they're very aware of other people's movements, of the rhythms.

Elizabeth (01:04:35):

That's a nice way to look at that, as the players all engaging in a set of rhythms.

Nina (01:04:42):

Absolutely. Also engaging in sound in ways that historically people have done. We go to a sports medicine conference, where people talk about vision, they talk about balance. Yet they're barely starting to think about hearing, when athletes have to be able to hear the sound of their clothing of their coach. I mean, there there's so much engagement with sound. By the way, our work with athletes has shown that elite athletes without a concussion have especially quiet brains. So as opposed to the child living with linguistic deprivation, we have the signature of the very healthy athlete as a very quiet brain, such that they can make clearer, better sense and engagement with their environment. So certainly one of the areas that I would personally like to investigate more thoroughly than we have the resources to do with the a minute at the moment, that's amazing is, rhythm therapies in the children and big 10 athletes that we are looking at who sustained concussions.

Nina (01:06:10):

Overall, I think a good way to end is I think that there is an enormous role certainly for sound and for engagement with sound since it connects us. You know, this is a time when we are divisive. There's a lot of depression and alienation. Since sound connects us, we should use sound to connect us. And I think that certainly music has an enormous role. Every child should have a musical education, and it's not just about people who go on to be professional musicians, but every child, just like every child should be physically strong and flexible. It's not just about the kids who make varsity. So similarly in medicine sound has an enormous place. And I hope that our world will come to be one where sound will be used and music will be used to strengthen the sound mind whether it's developing or it's healing. We're developing and healing

in various stages throughout our whole lives. But sound is such an important way of making our mind sound. And as I said, music is a jackpot, and there are ways that I think as a society, we could do a better job to make music an integral part of education and medicine.

Elizabeth (01:07:57):

That's a great summary. As a fellow mother, I really loved what I read in your book, about the requirements that you had of your children, which was one, they had to take their academics. Seriously. Two, they had to always tell you where they were. And three, they had to always practice their musical instrument. I loved that. And if they did that, they could have free rein. As a mother reading your book, my takeaway for my child was that the activities that were essential in my child's life were to play a musical instrument and then to play a sport, to have athletic activity. Then if you can manage a second language so that your child is bilingual, that's really the trifecta for creating the highest potential auditory brain that you can in your child, which is not only for childhood, but your research is showing that it creates a longevity of that full potential brain well into our older years.

Elizabeth (01:09:11):

And what does that look like? That looks like a brain that is clear, it's quiet. And it's able to understand the data, the signals that are coming in at its highest potential. So to connect, to connect. And I love that you bring that in. I love that you tie it into our current circumstances, because if we ever needed support in connecting and coming together, it would be right now, with the current world circumstances requiring a lot of love. I am singing many prayers every day out into the world in the hopes of harmony and healing and solutions. So in any case, I do want to say to you, Dr. Nina Kraus, thank you so much for all your work on behalf of all of us for all the good healing that you put out there. Thank you for speaking with me today. I learned so very much and I hope so very many other people will as well. Thank you for doing this interview and I wish you great luck with your new book and all of your very exciting upcoming experiments in the lab.

Nina (01:10:40):

Well, likewise, I've learned a lot by talking with you, Elizabeth. You're a very insightful interviewer and person.

Elizabeth (01:10:48):

Thank you. And again, one last time, we'll look at this very colorful cover *Of Sound Mind* by Dr. Nina Kraus, run out and get it. I had three people send this book to me. And I had to say, yes, I'm already speaking with her. So go get a copy for yourselves. You can get it right on Brainvolts website (access@ brainvolts.northwestern.edu). Thank you against Nina.