Dan Bowling
Music is an art form and music therapists who use this art form to help people, it doesn't really jive with the biomedical model and this is why doing the science is so important. It's to demonstrate that the effects of music are very real in biological terms and thus can be leveraged to treat biological pathology.

LuAnn Heinen
That's Daniel Bowling, a neuroscientist at Stanford Medicine whose research aims to advance new music-based treatments for mental health disorders. We discuss how music impacts emotional regulation and can activate the brain's reward system, how we can potentially scale digital music as therapy, and why this matters now more than ever.

I'm LuAnn Heinen and this is the Business Group on Health podcast, conversations with experts on the most relevant health and well-being issues facing employers.

Today I speak with Daniel Bowling about how and why music can alleviate symptoms of anxiety, depression, and ADHD, because the need, especially in young adults, is growing and usual treatments don't work for everyone.

Today we explore the power of music and its role in our mental well-being. Archaeological evidence shows that humans were making musical instruments around 50,000 years ago in the form of flutes fashioned from animal bones and woolly mammoth tusks. It's likely that singing and percussive sound making came even earlier. Like spoken language, music is a cultural universal, part of every known culture past and present. All of us have songs to soothe infants and amuse children, fight songs to motivate warriors going into battle, songs of courtship and love, music to inspire awe in God, comfort the living, and mourn the dead. We know music has the ability to reach inside and strongly influence our emotions. It can make us feel sad, peaceful, excited, engaged, and deeply connected. We also know that achieving some level of emotion regulation is central to mental health. It's how we handle stress, maintain relationships, perform at work and in life, basically achieve well-being.

Our guest today is Dr. Daniel Bowling, a neurobiologist, and we'll ask him to help unravel what a musician friend of mine calls the sonic mystery of music.

Welcome Dan, and thank you so much for being here.

Dan Bowling
Hi LuAnn, it's a really nice introduction.

LuAnn Heinen
So intuitively and from experience listening, most of us know that music can affect our emotional state, but how exactly does that happen?

Dan Bowling
Yes, so like you spoke to, music has a profound impact on emotion, on the way that we function socially and on the function of our brains. A really important thing about the biology of music is the realization that it's rooted in social communication. There's an ancient history essentially between sound and communication and it starts with the voice, which is an ancient thing in of itself that basically began when fish crawled out of the water onto the land. They had a little valve that they used to protect their lungs when they're underwater, and that's become our voice box over hundreds of millions of years of evolution. And the tone and the rhythm of our voice really conveys a lot about how we're feeling, and you can see this in other animals as well. You can tell a good deal about how an animal is feeling by the way that it's sounding. Is it vocalizing rapidly and with a lot of scratchy high-frequency energy or is it making more soft tones? In humans, this starts already in the womb, so this connection, we start picking up on it very, very early. Around 26 weeks of gestation, the fetus starts responding to its mother's voice, sound of its mother's voice, tone, the rhythm, and also others around the mother, consistent voices in the environment. And this kind of sensitivity to the voice develops to the point where in the days after birth, the infant already has a very strong preference for its mother's voice. So already you kind of have this integration between the properties of sound and attraction and emotion. This kind of auditory vocal connection is then used

directly by mothers and parents to help the infant regulate emotions. So the soothing tones that we use in the so-called motherese when we speak to infants, the lullabies that we sing, is the beginning of trying to use sound to regulate your emotions. And then this of course goes on to scaffold language learning and social communication and social connection. Really in the kind of evolutionary and developmental story of music and the connection between sound and emotion is really deep and it starts right away in human development. In that context, that's kind of the roots of where this comes from, and that gives music the power to engage the brain on a very fundamental level. Musical tones and rhythms engage diverse networks of brain regions that are involved in very fundamental processes like motivated behavior, rewarding behavior, the same networks that drive us to seek companionship, food, drugs. You know the saying sex, drugs, and rock and roll is really true. Music engages these networks and these networks also connect to a wide array of emotional circuitry that's involved in feeling good, feeling bad.

LuAnn Heinen
Is there any scientific basis to choose certain kinds of music if we're trying to, as a coping strategy, self-regulate our emotions?

Dan Bowling
Yes, absolutely. There's a fundamental connection between different acoustic properties and emotion, and this again comes from the roots of emotion and sound in vocal communication. In the same way that you can tell a lot about how somebody's feeling from the sound of their voice, you can tell a lot about music from the different acoustic properties that are involved. Calming music will be different than music that excites you. Music that is uplifting and provides you with positivity and energy will be different than music that is cathartic and maybe signaling anger or sadness. It really depends a lot on what your goals are. A piece of this is also, you know, what you like. People are different in this respect, and there's no one-size-fits-all, but there are fundamental properties that extend across different preferences as well.

LuAnn Heinen
Your research is on the application of music to people who are experiencing depression, for example, as well as anxiety and ADHD. So what's going on in the brain when someone is experiencing depression and how can music intervene in a therapeutic way?

Dan Bowling
Right, so depression is complex and what's called heterogeneous. You can have depression in many different ways, but the core symptoms of depression, low mood and what's called anhedonia or a loss of pleasure and interest, are related to dysfunction of fundamental brain circuitry that's involved in motivating and rewarding our behavior, causing us to do things, giving us drive, rewarding us when we succeed and our basic emotional tone around that. These circuits are the same ones that are affected by music. What we know from studying the neurobiology of music, when people are listening to music particularly, is that music that we like engages these networks in exactly the same way that, say, food does, sex, drugs of abuse, social companionship, feeling connected, all of those things, music engages this system directly. This system is essentially called our reward system, and it's what's talked about commonly as the dopamine system. So music drives dopamine responses essentially, and other chemicals that make us feel good.

LuAnn Heinen
So this is a temporary kind of manifestation, it's not changing mood more sustainably. How is that similar or different from, let's say, a prescription for Prozac?

Dan Bowling
Right, this is kind of the cutting edge of research. I think most of the thinking around how music affects us is in the moment, but if you systematically engage with music over a period of time, say you use it like a drug, you do it daily for a certain amount of time, and with an intentional goal, the effects can be longer lasting. But how long, we're not quite certain about. My presumption is essentially that the more you engage to some limit, the better it is and if you continue to engage, you'll continue to get the effects.

LuAnn Heinen
Dose response. Well, traditional mental health support, which is often therapy and a prescription, helps maybe a third or a little bit more of people. This does explain why there's a lot of looking around for novel approaches.

Dan Bowling
Exactly. Yes, I think in many ways, psychiatry has been the least effective branch of medicine. That should come as no surprise, the brain is arguably the most complex organ. When you're dealing with mental health and psychiatry, you are at the confluence of people's entire life history, their neurochemistry, their neuroanatomy, and so it's extremely complex. But the truth is that the kind of first line treatments, psychotherapy and pharmacotherapy or drugs, they only help about a third of people. It varies somewhat by disorder. The number one-third really comes from depression. It's probably more like one-half or maybe even two-thirds in conditions of anxiety, depending on what they are. The bottom line is that there are a large portion of the population with mental health disorders that are unsupported or unhelped by traditional therapies that are also costly and can have serious side effects.

LuAnn Heinen
And there's a shortage of therapists and there aren't wonderful outcomes data for talk therapy either.

Dan Bowling
Right, so talk therapy can be extremely effective and a lot of that is about kind of the social connection that you make with your therapist, but that doesn't always come. It can take a lot of looking around. It can be hard to find the right person. Sometimes you don't find the right person. We don't really know how it works. We don't really know how psychotherapy influences us on a neurobiological level and thus makes it hard to capitalize on that and grow it. That is a limitation.

LuAnn Heinen
Is the mechanism similar for anxiety as it is to depression? I mean are these working in the same way or are they different circuits and different pathways and different symptoms?

Dan Bowling
They're related, but they are highly overlapping. What's comorbidity, which is like the portion of people with depression who also have anxiety for example, is very high. It's 45% approximately. So they are intertwined and the neurobiology is also intertwined. There are common networks and different networks that are involved in both.

LuAnn Heinen
I'm wondering how you came to focus on leveraging the emotional power of music, especially in young adults. How did that come to you or did you find it?

Dan Bowling
Yes, so I have a long history in academia of studying music, particularly its underlying biology and why it's so powerful. I was always interested in this kind of from an intellectual perspective. This interest took me abroad. I spent some time in Singapore and some time in Vienna in Austria studying kind of the biology and evolution of musical behavior. When I had the opportunity to come back to the United States, it was in a medical school, in a medical context, and I very quickly realized that I had to think about how to apply what I knew to the problem of helping people. I was very gratified to find out that all these things we know about music, all the ways that it affects our brains, are highly overlapping with the way that our brain can dysfunction in mental illness. What are the fundamental things that music does? It modulates emotion and delivers pleasure. This is why people listen to music all around the world. If you ask global surveys, these are the top two reasons. And what are the fundamental things that go wrong in depression? Low mood, low emotional tone, and loss of pleasure. So it's kind of a lock and key situation for music and it's a similar situation for anxiety.

LuAnn Heinen
I would think live music would be much more powerful, but so much of what we hear now is digital or maybe on YouTube with a video. Do you need to be hearing musicians live? Do you need to be with other people in the same space listening?

Dan Bowling
It really depends. There's definitely truth to that, but what if you have social anxiety. What if you don't feel comfortable in a crowd, which is an increasing sentiment. There's also a sense in which even listening to music by yourself may still be an inherently social experience. If you think about the history of music making, it's only very, very recently that it's been something that you can do by yourself. The first gramophone, what was it - 1800s, 1850; then we get the Walkman in the 1970s, 80s. So for the vast majority of our music-making history, we've needed to be with other people. The neural circuits that are involved in responding to music carry that through.

LuAnn Heinen
What about group singing? I know you've got an interest in vocal music. How does group singing influence affect, stress, mood?

Dan Bowling
Yes, so singing is great, particularly if you don't feel too self-conscious and you can engage with a group of people who you feel connected to. Singing can really bring us together. It's probably one of the prototypical forms of musical behavior, particularly the kind of synchronization with other people. And it's synchronization not only of behavior but also of emotion. So when you do that with other people, you get a major boost in terms of reward, in terms of positive emotion, in terms of feeling understood, in terms of feeling connected, and it's related to neurochemistry in a very fundamental way.

LuAnn Heinen
Major bonding.

Dan Bowling
Exactly. There's a reason why people sing, you know, national anthems, why military drill typically involves singing. These things, rhythm and tone, and sharing these experiences really bind us together.

LuAnn Heinen
I was thinking also of, you know, our body has rhythms. We have circadian rhythms and we have our heartbeat. How does that tie in?

Dan Bowling
Yes, so rhythm means a lot of different things in a lot of different contexts. There's very frequently people talk about the heart as where kind of rhythm and music comes from. I think the evidence there is actually pretty limited, even though that there's kind of an anecdotal intuitive truth to it. I think probably rhythm and music has a lot more to do with the rhythm of our voices. Because again, music is this fundamental form of social communication that kind of has its roots in our use of sound to touch each other. It is the kind of rhythm of our voice, the cadence of my voice when I talk and what you take from that, that is distilled in music and exaggerated to create these patterns that we can really glom onto and engage with.

LuAnn Heinen
That's so interesting. My husband often gets, when I think he's getting mad at me, he says, it's not what you're saying, it's how you're saying it.

Dan Bowling
Precisely, yes. That's the thing, you know, if somebody says something to you with a tone of voice, it was really great to meet you. You know, you don't take any positivity away from that. There's no connection. Tone trumps the literal meaning of what you're saying.

LuAnn Heinen
The other thing music can do, we know, is support and encourage movement, which is so good for us and releases all kinds of other good feelings. How does music do that?

Dan Bowling
Yes, so this is a really interesting story and kind of the music neuroscience has come to really engage with the rhythm and kind of the power of rhythm, which is kind of self-evident in music, particularly music, the kind of music that's exploded since rock and roll and since kind of the African diasporas and the kind of introduction of all these syncopation and these patterns into music. What we know from music neuroscience is that rhythm, regularly repeating sounds in a certain range, engage not only your auditory system, but also your motor system. If you put somebody in a brain scanner and you play them a groovy rhythm and you say, don't move, you have to stay completely still, you'll still see motor activation. There's kind of a cycling of neural activity that happens where you're hearing sound and then that sound is moving from your auditory system to your motor system as a way to predict the next forthcoming sound and you can engage in movement. That's why, you know, if you hear a beat it can be hard not to tap your foot or bob your head. It's a really deep connection for us.

LuAnn Heinen
Well that reminds me, I think you mentioned that in Parkinson's disease, people have a lot of trouble moving voluntarily when they want to and controlling their movements, but if the music starts, that changes.

Dan Bowling
Yes, so music is kind of one way to supply energy and motivation to the system that is dysfunctional in Parkinson's. It's kind of a loss of dopamine input to your reward centers from certain populations of cells. You can kind of circumvent that pathway and supply the motivation for movement through sound through another pathway that's preserved.

LuAnn Heinen
Does that have to be people who previously danced or danced earlier in their lives or would it work for anyone?

Dan Bowling
Well, not necessarily. It would certainly help. By and large, most people have this capacity to engage, especially rhythmically with music. It's about 95%. There are people who are so-called beat deaf.

LuAnn Heinen
Oh, that's a real thing?

Dan Bowling
Yes, so you can be insensitive to tones and insensitive to rhythms to the point where you can't tap along or you can't sing in pitch or you can't hear if something's wrong with the pitch. But it's relatively rare, probably less than 5%.

LuAnn Heinen
Well, let's talk about music therapy. What is it and maybe what isn't it?

Dan Bowling
Yes, so music therapy has a long history. It has its origins in the United States in inpatient care for veterans in World War II, special education, and of course therapeutic use of music goes far back beyond that. It is a highly diverse and varied field. There are many different perspectives and many different types of therapy, different approaches, different methods. In many ways, it's the most advanced form of applying music towards a goal, whether that's something clinical or something functional. However, like psychotherapy, it is difficult to define and difficult to know what parts of it are effective. The solution that's been landed upon, I think there's a famous book called *Defining Music Therapy*, it's in its third edition, they essentially define music therapy as being administered by a trained music therapist. That's somewhat circular, but it allows for this diversity and variation.

LuAnn Heinen
So they are considered health care professionals, but their services are not typically covered by insurance plans. I think that there is some funding at the state level through state departments of mental health, interestingly, and developmental disabilities programs for autism, ADHD, and Down's. Not every state. Sometimes Medicaid programs will support and Medicare for patients in rehab facilities. If they have a neurological condition, you know, it could be helped. But it looks like coverage is pretty unusual, and there also aren't that many certified music therapists.

Dan Bowling
Exactly. This is why the science is so important. I think a lot of the interest here in novel therapeutics, because of the difficulties we have in treating people in psychiatry, are a big part of this. Yes, it's been difficult. Music is an art form and music therapists who use this art form to help people, it doesn't really jive with the biomedical model. This is why doing the science is so important. It's to demonstrate that the effects of music are very real in biological terms and thus can be leveraged to treat biological pathology. This is kind of where the field is at. I think, you know, some of the things you listed, for example, stroke rehabilitation, Parkinson's, these are some of the more established uses of music in medicine. When it comes to conditions like anxiety and depression, there's a lot more work to do, even though there are a large number of randomized controlled trials showing that music therapies can be effective.

LuAnn Heinen
For Alzheimer's disease, too, I think.

Dan Bowling
Alzheimer's disease is an interesting one. Essentially, there was tremendous excitement about the power of music to reconnect people with Alzheimer's. You often see people with Alzheimer's, they come alive when they hear a song that they know. Tony Bennett famously can perform songs from his repertoire. But once the music stops, they kind of recede to a state of dementia. So the kind of initial excitement about the possibility that music might be able to provide some sort of curative effect has not really panned out. It can still be a tremendous benefit for quality of life and for reducing agitation, irritation. So those things are very important still.

LuAnn Heinen
What is your experience with ADHD and how might music support people struggling with ADHD?

Dan Bowling
Yes, so ADHD is really interesting and the situation is a little different than, for example, in depression or anxiety. This is kind of an emerging area of research. ADHD is related to kind of having low what's called executive function. Basically, the front part of your brain can have a hard time suppressing what are very natural tendencies to drift when we're bored, when we don't feel engaged. Some of us do more of that than others and sometimes it's out of sync with what you need to do, for example, at your job or in school. It is in these cases that music, especially stable rhythmic music that has been created to not be too distracting, something that you can put into the background but that has a stable texture that you can still engage with. This can really take some of the pressure off the front part of your brains that have to be working constantly to keep you from floating. And it can kind of provide you with motivation and drive by engaging these looping circuits between your auditory system, your motor system, by supplying energy and motivation through kind of repetition. Rhythm can kind of supply drive in this way and help you maintain focus and stay engaged.

LuAnn Heinen
Wow and other forms of neurodiversity as well?

Dan Bowling
Yes, I think that this rhythmic capacity of music pretty much applies across the board. Interestingly, there's some new evidence coming along that seeding music with particular frequencies, such as those that are evident in the brain when you're engaged in a task, might be able to enhance focus. This is especially seems to be true in people who have tendencies towards ADHD.

LuAnn Heinen
Did you say seeding music?

Dan Bowling
Yes, so essentially adding certain frequencies to music and doing so in a way where it doesn't sound bad.

LuAnn Heinen
That's really fascinating.

Dan Bowling
Oh, there's one other piece here that I wanted to mention this context, which is something called groove. So groove is something maybe you understand intuitively, but in music psychology, it's a technical term that refers to how much music makes you want to move. Groove is based in rhythm and it's highly rewarding. So when music is groovy and you can move along with it, it feels good. You know, a lot of new therapeutic music is really engaging this property of music to stimulate your auditory motor loops and to provide you with energy and motivation.

LuAnn Heinen
It feels like one of your messages is we should be taking music much more seriously in our lives and also in health care and that it's understudied, needs more science. But we do know that it has protective effects on the brain for everybody. Does that apply, obviously for creators of music, people who are composing music and performing music, but what about the appreciators?

Dan Bowling
Yes, essentially, if you are someone who likes music, which is most people, or you're somebody who has a particular appreciation, it's not just entertainment, it's not just something you do to have fun. You should really take it seriously as a therapeutic, essentially, something that you can systematically engage with to feel better. That's really not part of popular culture around music, which has really been driven by a different impulse to create music that's as rewarding and as attention grabbing as possible. Well, that's been really important in expanding access to music, but it's also disproportionately grown a particular type of music. The power of music, the emotional power of music is far more varied and can do a lot more for us than it does. But it will necessarily involve a lot of getting the message out there, but also developing new tools that lower the bar for engaging with music intentionally and therapeutically.

LuAnn Heinen
I think you're referencing there's a huge entertainment industry and people are making music that will become popular, become a hit, not necessarily with a therapeutic intent, although there's plenty of music out there that is therapeutic and meets criteria. We'll talk a little bit about that.

Dan Bowling
Yes, that's right. Popular music is great if you are going for positivity, energy, motivation, which can very often be therapeutic. Probably is not what you need if you're feeling very anxious and you need to calm down. If you need to focus on something, if you need to kind of speak to a state of depression and lift somebody out of it, you know, if somebody's feeling depressed and you hit them with the latest pop single, it's not necessarily going to land.

LuAnn Heinen
Do you have any advice for listeners when it comes to their personal playlists and how to find what may be therapeutic as well as energizing and motivating?

Dan Bowling
Yes, it's interesting. People often ask me as a neuroscientist, what are the properties of music that have certain effects? I can definitely speak to that, but it's also important to kind of respect your own intuitions here and also to note that this is what musicians do and that's what they've been doing for a long time, targeting certain types of feelings with certain types of sounds. It's very intuitive things. I mean, if you want to have music that's energizing, what should the tempo be like? Well, it should be fast. If you need music

to calm you down, then what should the tempo like? Well, it should be slow. There are more subtle things like how energy is distributed in certain frequencies. High frequencies tend to be very arousing. You can think about shrill sounds as something that grabs your attention. Low frequencies are very good for providing a stimulation to your kind of your movement and to your kind of rhythmic engagement of your brain. Melodies that are simple and repeating are something that you can get into and background or really move along with, enjoy. Melodies that are more complicated and complex tend to have more of a cognitive element to them. Same thing with harmony. Simple chord progressions are broadly appealing and can supply a lot of positivity, whereas complex chord progressions are more cognitive. Things like the major-minor distinction, especially in kind of Western music, if you've grown up around Western music, are important for affect or for emotion. I could go on. There's a long list of parameters that are associated with emotion.

LuAnn Heinen
Give us a couple of well-known songs that are motivating and energizing.

Dan Bowling
Yes, so *Eye of the Tiger*, that's a good one for feeling motivated. Other popular cultures, like *Lose Yourself* by Eminem. A lot of pop music is like this. A lot of Lady Gaga, for instance. This is music that I like largely.

LuAnn Heinen
Well, I hear about your collection. What about something particularly calming and relaxing?

Dan Bowling
Yes, so this is a little bit more difficult because it tends to be less popular, although it can still be very popular. But again, you're looking here for kind of slower melodies, slower rhythms, slower tempo, less kind of high-frequency energy. A lot of instrumental work with kind of even a lot of classical piano or guitar can be good. Vocals can also work in this context if they are calm. The biggest factor is probably rhythm for conveying kind of a lower energy state.

LuAnn Heinen
So how can we scale music as therapy for mental health? Is there something that our large employer audience might be able to do? Any suggestions there?

Dan Bowling
Yes, so there are a number of things. I think, again, related to getting the message out is the idea that you can engage with music intentionally and therapeutically, and that you should do so, especially if you're someone who really likes music, teaching people essentially about how to use music in these ways. But it's also important to note that people are different, and not all music will be positive. We know that music that's out of sync with the way that you feel or music that you don't like doesn't help, and in fact, it can really hurt you, it can really hurt your productivity. This kind of individualization or personalization of music means that it's less likely to be positive if you're playing one track over the PA system for everybody to listen to. What kind of the new generation of listening-based digital therapeutics are focused on is really trying to supply the right music to people at the right time. This is essentially what music therapists do, but there aren't nearly enough music therapists to meet the clinical needs. Only about 11,000 in the U.S., compared to 60 million with mental health disorders.

LuAnn Heinen
Well, so when you finish this interview, if you put on something to listen to, what will it be?

Dan Bowling
These days I tend to lean towards forms of music that are highly accessible. These are things like EDM, they have very steady beats, simple tonality, and they provide me with energy when I'm writing grants.

LuAnn Heinen
Oh, yes, grant writing. Dan, thank you so much for your time today. This was fascinating.

Dan Bowling
Great. It was a pleasure to be with you.

LuAnn Heinen
I've been speaking with Daniel Bowling, a musician who earned his PhD in neurobiology at Duke University for work on the biological basis of emotion and musical tonality. Daniel's passion for music drove his postdoctoral work at the University of Vienna on the neurophysiology of synchrony and rhythm, and his current work at Stanford focused on music-based treatments for mental health disorders.

I'm LuAnn Heinen, and this podcast is produced by Business Group on Health, with Connected Social Media. If you liked the episode, please share it and leave a review.