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The Nerve:Music and the Human Experience
Episode 1, Wired for Sound (Music and the Brain)

Patti Schmidt: Hi, I'm Patti Schmidt, and this is 'Inside the Music,' a program that looks at the context of music. At the conclusion of the Peabody award winning CBC radio series, 'The Wire,' the impact of electricity on music, host Jowi Taylor said, 'We ourselves are wired for sound; after all, it's a faint electric current that drives our own nervous system that transmits music from the eardrum to the brain and gives us that tingly feeling when we hear something perfect.' The team that brought you 'The Wire' brings you a new six part series that explores exactly the source of that tingly feeling. It's called 'The Nerve: Music and the Human Experience.' Each episode will look at the power of music through the lens of one particular facet of the human experience. On episode one of 'The Nerve,' it's 'Music and the Brain.'

SFX: [echoing background sounds], a male and female voice intone 'corpus callosum' 'war' 'rhythm' 'auditory cortex' 'pitch' 'harmony' 'evolution' [inaudible]

Music: organ music begins; throatsinging

Jowi Taylor: [voice distorted male] The Nerve

Jowi Taylor: Sometimes I feel like music is nothing – just a bunch of sounds arranged into patterns, completely ephemeral. I could find a rhythm in the rain on the roof, but it could, literally, dry up [snaps fingers] just like that. I've come up with great melodies in my head, only to have them lost in the din of a shopping mall. It's kind of like us people – we're a collection of amino acids and proteins animated by hormones and neurotransmitters. Everything we do, all the stuff we make, is a way of insisting that we're at least capable of being permanent. Music can't build a building, but I can, and slap my name above the doorway if I like, and yet, after I'm dead and gone, people not yet born will sing songs written before I came to be. I'm Jowi Taylor. This is The Nerve.

Music: piano

SFX: heartbeat, electrical interference

Jowi Taylor: Music is in my head.

Music: piano music transitions into Julie Andrews as 'Maria' singing, 'Let's start at the very beginning, a very good place to start. When you read you begin with…' [Brigitta von Trapp says] 'A, B, C'. When you sing you begin with do, re, mi, [von Trapp children sing] 'do, re, mi,' [Julie Andrews sings] do, re, mi. The first three notes just happen to be, do, re, mi, [von Trapp children echo] 'do, re, mi' [Julie Andrews sings] 'do, re, mi, fa, so, la, ti…'

Music: one piano note struck and processed

Music: [Julie Andrews] Oh let's see if I can make it easier

Marshall Chasin: Hearing is one of your senses

Music: one piano note struck and processed

Marshall Chasin: I'm Dr. Marshall Chasin, I'm the Director of Auditory Research at the Musicians' Clinics of Canada.

Music: one piano note struck and processed

Marshall Chasin: You use the sound coming in through your ears, going up through your auditory, or eighth, nerve, up to a certain part of the brain called the auditory cortex where you can receive the sound

SFX: a sharp sound echoing and bouncing like in an echo chamber

Marshall Chasin: The ear is made up of three major parts: the outer ear – that's the part that we see that we hang [chuckles] our glasses on, then we have the middle ear – that's behind the ear drum where the three little tiny bones are situated, then we get into the inner ear. The inner ear is

the size of my small finger nail, packed with 13 to 15,000 nerve endings and filled with fluid...

Music: piano note continues

SFX: distorted sounds ('brain' SFX) come in

Marshall Chasin: …and as the sound comes in from the outer ear through the eardrum and the middle ear, vibrations are set up in the inner ear that then cause the nerve endings to bend and flex, and this bending and flexing causes neurological impulses to go up the eighth auditory nerve up to the brain, so we say, 'Ah, we hear it.'

Music: a few bars of slow piano music by Arvo Pärt

Sandra Trehub: I must say that I was stunned by what I learned from infants about music, and that changed the way I relate to music…

Music: piano music continues

Sandra Trehub: … I found that babies could do most of what we could do: they listen to music the way we do, they notice the things that we did, and it really started me thinking about music – what it could do for us – the fact that we're able to learn what we can about it and the fact that none of that would be possible if we didn't start with a fundamental interest in it…

Music: first few bars of Dvorak Cello Concerto

Jimena Llopis: You know, music is everywhere, it's in everybody's life – in fact it's inside your body so, you know, your heart beat, your… your rhythm of your body, and it's outside everywhere so you just have to listen, I mean, you see the birds, and the… the wind blows… so music it's really everywhere, it's part of ourselves, it's part of our… of our universe.

Music: first few bars of Dvorak Cello Concerto; Pärt piano music continues

Daniel Levitin: Music is part of the sound signalling system and the sound system that we have, our sense of hearing, actually comes evolutionarily from detectors that, you know, it's related to detectors that insects and fish have for detecting disturbances in the environment… What you need to know if you're a fish is if, you know, there's something moving towards you and the way you know that is by current changes.

SFX: stream sounds begin in foreground… move to background

Larry Kirkegaard: If you watch a stream moving past an object in the water, you'll see in response to the tiny rivulets, the waves that come into it, a whole series of very small ripples reflecting back from it or reflecting forward from it.

SFX: stream sounds

Daniel Levitin: If you're an insect, it's the same thing, you need to know if there's a sudden gust of wind, if there's a predator approaching, and air has this quality similar to water: that the disturbances move molecules that can push against a receptor that you have.

Music: piano

Marshall Chasin: Well, each sound has a vibration. That vibration goes into the ear. It is slightly amplified by the outer part of the ear that we see – the pinna – goes to the eardrum, the eardrum vibrates in synchrony with this sound, sets the little bones in the middle ear vibrating to and fro.

Music: piano

SFX: stream, bird sounds, distorted sounds as before

Daniel Levitin: Insects have these little hairy things on their legs that can sense the movement of the air and these developed into hearing for us. Hearing is essentially a very sophisticated and nuanced way of detecting changes in the air …

Jowi Taylor: Hmm…

Daniel Levitin: … Short abrupt sharp changes that are non-repetitive may signal a danger, as opposed to, say, the rain on the top of your hutch if you're a rabbit…

Jowi Taylor: Right…

Daniel Levitin: …or the wind swaying a tree in a very rhythmic way – you don't need to alert and startle to that because it's something regular…

Jowi Taylor: Yeah…

Daniel Levitin: …but you do need to alert and startle to a sudden foot step of a mountain lion or a rock coming your way.

Jowi Taylor: Right, especially something that's out of pattern…

Daniel Levitin: Yeah, exactly.

SFX: stream sounds and electronic distortions intensify in volume in background

Marshall Chasin: …and this vibration is transmitted through the middle ear to the inner ear, or the cochlea, and these bones set up a vibration in the fluid of the cochlea which causes the nerve endings to vibrate in synchrony, sends out a neurological impulse to the brain… and we say, 'Ah, we've heard it.'

Music: first few bars from Dvorak's Cello Concerto

Daniel Levitin: The brain's a giant change detector, Jowi …

Music: piano starts playing Beethoven's Moonlight Sonata in background

Daniel Levitin: … and it easily habituates – becomes numb – to repetition and then is startled into paying attention again with anything out of the ordinary.

Music: Beethoven continues for approx. one minute, then fades into background and begins looping

Jowi Taylor: When we listen to something, we sense timbre, we sense location, we sense all these incredibly complex… it seems too much for something that's a set of transmitted vibrations. What else is going on?

Marshall Chasin: The ear is really no more than a microphone. It's a diaphragm we call the eardrum which transmits the sound up to the brain. I think part of the reason that the sound sounds different or music sounds different to us than just a… an input to a microphone is that we have two ears and then we have something called the human brain which is the most powerful computer around.

SFX: brain SFX

Marshall Chasin: Having the two ears actually allows us to pick out the signal of what we want to hear and disregard the background noise – the stuff that we don't want to hear – and then the sound is integrated in a very complex manner in the human brain…

Music: Beethoven continues … moves into background

Marshall Chasin: …We know that this is the case because there are some people from time to time who through trauma or disease lose one ear but have an intact other ear, and although they can hear speech they don't really appreciate the subtleties of music like the way you or I might appreciate it.

Music: Beethoven continues… moves into background

Marshall Chasin: Each sound, let's say, take the example of a middle sound on the piano keyboard [SFX: piano note]… has a vibration, and the vibration has a certain height or amplitude, that's the loudness [SFX: loud piano note], it also has when it starts, and that's called the phase... and, ah, the human brain has a wonderful ability to detect phase differences… [SFX: piano note on left] …

for example, if a sound is off to our left hand side, the sound is going to hit our left ear a moment before it hits our right ear. [SFX: piano note on left] And that difference in timing, or difference in phase, allows us to say, 'Oh, its over to our left hand side.' A beautiful sonata from Beethoven or beautiful music from a rock or pop group… not only are we looking at the range of intensities and vibrations, but we're also looking at the phase relationships, the fact that it's in front of us or maybe over to the left of us, or maybe we're in a room and, yes we're hearing the sound up on stage, but we're hearing the reflected sound off of the ceiling, off the wall. Uh, nobody can truly enjoy music in a non-echoing or non-reverberant environment. We need a certain amount of background reverberation or echo to give us the joy of music.

Music: Beethoven music continues for awhile

Daniel Levitin: Uh, what's happening when you hit a single note on the piano… I mean we could talk about *that* for an hour… there's so much going on… the string is vibrating in multiple modes. [SFX: piano FX] It's causing some sympathetic vibrations with other strings, causing vibration to occur on the sound-board of the piano and other parts of the piano vibrate. All these things are very complicated. [SFX: piano FX] Essentially, all this causes disturbances of molecules in the air. Those molecules set up a traveling wave – a pressure wave – that impinges on your ear drum causing it to wiggle in and out. The remarkable thing is that you're able to detect and pull out a single entity, when you consider that the only information that your brain has is your eardrum wiggling in and out…

Jowi Taylor: Hmm…

Daniel Levitin: …That's the primary sensory receptor – your eardrum wiggles in and out and all of that somehow becomes the auditory experience. You have no more information than that. It's the pattern of wiggling – the rate of it, and the depth of it – [SFX: piano FX] ah, that your brain has to use to extract the information. That sets up a kind of

neuro-chemical and mechanical chain of events. The interesting thing there is that different parts of your brain, um, as soon as the signal makes its way up from the eardrum, different parts of the brain process different aspects of the sound, so pitch is extracted in one part of the brain and tempo in another and timbre in yet another – and all of these different pitch things that were extracted are formed into a representation of melody somewhere else and it gets put together later. You don't realize it because it happens so fast… that it's happening without your conscious awareness. Now that I've told you this process you don't have any control over it, you can't decide to turn off the pitch mechanism even if I showed you where it was in your brain – it's automatic, you can't turn it off. Uh, but at some point everything comes together and you have this sense of 'Oh, well that was the melody and these were the instruments playing it…'

Jowi Taylor — Yeah…

Music: repeating piano note SFX… pitch gradually dropping

Daniel Levitin: My name is Daniel Levitin and I'm a Cognitive Neuroscientist at McGill University and the author of 'This is Your Brain on Music – The Science of a Human Obsession.'

Music: repeating piano note SFX continue

Jowi Taylor: It's part of common currency now to be able to talk about parts of the brain: the language part of the brain, the spatial part of the brain. What's the music part of the brain?

Daniel Levitin: Well that's an interesting thing – there isn't a music part of the brain. Music is distributed widely throughout all different parts of the brain. It's more accurate to say that every part of the brain has a music part. We know that from a number of different studies, from people who get lesions to widely different parts of the brain and lose some aspect of their musical functioning. We know it from neuro-imaging studies where we can track which

neurons or populations of neurons are firing in response to music…

SFX: ricocheting noise

Daniel Levitin: …But to give you an example, when you're listening to a piece of music, whether you know it or not, and whether you're a musician or not, there's a part of your brain that's trying to figure out what's going to come next…

Music: Julie Andrews sings, 'Doe, a deer, a female deer'

Music: repeating piano note in background

Daniel Levitin : Just as it does if I were to start a sentence like, 'The pizza was too hot to…'

Music: Julie Andrews continues '… ray – a drop of golden sun'

Daniel Levitin: …your brain's trying to… you come up with a plausible hypothesis about what I'm going to say next. I'm probably going to say 'eat,' or 'touch,' maybe, but there aren't that many… I can't say, 'The pizza was too hot to sleep.' [Levitin and Taylor laugh]

Jowi Taylor: Right. You could, but you'd be put away…

Daniel Levitin: Right… [laughs] But with music we're doing the same thing. We hear a chord progression, we hear notes, and there's a part of our brain that's sensitive to the structure and trying to figure out, again, we may not be aware that this is going on, and that's in the frontal lobes just behind the eyebrow.

Music: Julie Andrews continues, 'me – a name I call myself, far – a long, long way to run…'

Daniel Levitin: There's another part of the brain that's tracking the beat and trying [Levitin starts to clap rhythmically and continues] to predict when the next pulse will be – that's at the back of the brain, in the cerebellum.

Music: Julie Andrews continues, 'sew – a needle pulling thread, la – a note to follow so, tea – a drink with jam and bread, that will bring us back to…'

Daniel Levitin: There's a part of the brain that extracts pitch, in the temporal lobes…

Music: repeating piano note in background fading in and out

Daniel Levitin: It's really spread out all over.

Jowi Taylor: These… centres are linked? Their language is chemical, then?

Daniel Levitin: It's electro-chemical, so neurons have electrical activity and they cause chemicals in the brain to either be taken up, or to be excreted… and the synapse, which is a word we all know, is the cleft between two different neurons that takes up different neuro-chemicals such as… neuro-transmitters such as dopamine and serotonin and things like that… epinephrine and norepinephrin…

Jowi Taylor: So … and what is dopamine exactly?

Daniel Levitin: Dopamine is a so-called 'feel-good' hormone. It's released by the brain in a naturally… response to different events. One of the things that's interesting about it is that if you win a bunch of money, or you eat chocolate, or you have an orgasm, dopamine is produced as an indicator that this is something pleasurable, and in my laboratory, we conducted the first study that concluded that dopamine was produced when you listen to music you like.

SFX: electrical pinging noises, zap!

Jowi Taylor: [voice distorting] This is 'The Nerve' [echo 'The Nerve'] … episode one… So, I'm driving along in the summertime in a rented car… and I've got the windows down and the radio up… 'American Woman' by the Guess Who comes on… now, I don't normally listen to classic rock stations… but this song is so ingrained in

my head from childhood, that right at the perfect moment, after the second repeat of the riff, right along with Burton Cummings, I go, 'Uhhn!' …I've got probably hundreds of songs in my head where I know every hit, and every swell and click and echo, every note… That amazes me. What amazes me even more is when I hear something I've never heard before and I feel it entering that part of the brain. Like this novel thing just lining up, falling into place, even while it totally surprises me.

SFX: buzzy noises

Music: Stevie Wonder's 'Superstition' begins … continues in background

Daniel Levitin: We've learned through a lifetime of listening that there are certain chords, and certain notes that we expect to hear…

Music: layered on top of the Stevie Wonder, Julie Andrews sings in the foreground, 'do, re, mi, so, la, ti…'

Daniel Levitin: What we find rewarding about music is…

Music: in the foreground Julie Andrews continues, '… do, oh, oh, oh…' child calls, 'Do!'… song retreats into the background and continues…

Daniel Levitin: As I said, we're trying to figure out what's going to come next and the composer is trying to stay a step ahead of us… The composer's job is to reward us enough of the time that he or she holds our attention…

Music: von Trapp children shout, 'Fa!'…

Daniel Levitin: …you know, so that we have some sense that we know where it's going…

Music: in the foreground, the von Trapp children shout, 'So!' Julie Andrews sings, 'sew – a needle pulling thread, la – a note to follow so'…

Daniel Levitin: …but he or she, the composer, has to violate our expectations some of the time in order to surprise us otherwise it becomes boring…

Music: Julie Andrews sings, 'that will bring us back to…' 'Superstition' begins again…

Daniel Levitin: …music that's entirely predictable, like a story that's entirely predictable…

Music: 'Superstition' opening drum beat looped in background

Daniel Levitin: …is not interesting…

Jowi Taylor: Hmm…

Daniel Levitin: …Music that's too surprising, we're on edge, because we don't really know where it's going…

Music: Schoenberg piano music begins…

Daniel Levitin: …so the balance has to be there.

Music: piano replaced with Radiohead's melodic guitar playing in background (song 'Let Down')

Daniel Levitin: We find it rewarding when the composer is able to violate our expectations but in a way that still *feels* good. So imagine I'm listening to a piece of music and it takes some funny little turn that I didn't expect…

Music: drum crash joins electric guitar on offbeat…

Daniel Levitin: …but in retrospect, I realize 'wow, that's… that's pretty good. I never would have thought that it would go there – but I like it!'

Music: voices join guitar and drums

Daniel Levitin: When composer can do that a few times in a song…

Jowi Taylor: Hmm…

Daniel Levitin: … well that's the kind of song you can love for the rest of your life.

Music: song in background swells into foreground and plays out

Jimena Llopis: My name is Jimena Llopis and I'm the General Manager for Europe, the Middle East and Asia of Music Intelligence Solutions.

Music: Radiohead swells again then fades into background

Jowi Taylor: You're the developer of 'hit song science technology' – your company is. Can you describe to us how this technology works?

Jimena Llopis: Well, it's analyzing all musical parameters, you know, from a lot of melody parameters, rhythm parameters, brightness, harmony, pitch… and then there's some physical parameters: like, amplitude, you know, noise, and other things like that… And it was very interesting, because at the beginning we analyzed all the hits from 1950 on and we found out that there was very defined parameters, like a finite number of 'clusters' where the hit songs kind of cluster together. So what we do is, for each country we analyze the best window, normally, it's around five years, we see the clusters that are active at that moment for hit songs for that country, and then when a new song comes in, we can see if it's in a cluster that's kind of emerging or if it's an established cluster.

Music: Radiohead swells briefly then fades into background

Jimena Llopis: So, basically, we do a music analysis, we put learning systems on top of that and we're able to see what clusters, hit clusters, are most active at that moment for that country.

David Harrington: [over music] Music is incredibly mysterious… and anybody who tells you they think they know what it is or how it works, I would advise to not believe it [chuckles] because… what I can say, is that I've spent I don't know

how many years to this point trying to play the violin and being a part of many different musical adventures and I have no idea how it really works. It's, um… it's a mystery.

Music: song continues alone to end of song… 'brain' SFX follow

Patti Schmidt: I'm Patti Schmidt. This is 'Inside the Music' and you're listening to Episode One of 'The Nerve': Music and the Brain.'

Jimena Llopis: What we have is like a tool that can actually see this data in a way that was not, you know, we were not able to see before… but it's not like then you can say, 'OK so you have to put 2% of this, and 3% of that, and 20% of that'… So, you cannot do that… it's just like, you now, like an ultrasound – you can see now things that you were not able to see before in the music but you cannot create life from the ultrasound…

Music: repeating piano note SFX

Jimena Llopis: What seems to be happening is that there's a very interesting way that humans perceive music. You need to have, like, a good equilibrium between complete innovation or you know complete randomness of the music…

Music: Schoenberg piano music begins

Jimena Llopis: …and, uh say, you know, a single tone…

Music: one note on the piano plays

Jimena Llopis: …those are, like, the two extremes…

Music: 'Superstition' opening drum beat looped in background

Jimena Llopis: …both are annoying to the human ear, and, you know, the human brain and heart. So if you get the right combination of innovation and prediction, I'd say, it

seems that then that's best, like, for the human enjoyment.

Jowi Taylor: Can you give me an example of one that does it for you?

Daniel Levitin: Oh, there's so many, but I guess one example that's easy to talk about is the song, 'Yesterday' by the Beatles. The way that it surprises us is very subtle – almost all popular music that we listen to has phrases that are eight measures long.

Music: 'Yesterday' begins quietly in the background

Daniel Levitin: A measure is if you're counting along and tapping your foot… It's, typically, you count 'one, two, three, four' – that's a measure. Most songs have eight measures for a verse, and then another eight measures for a verse, and then they may go to an eight measure chorus. 'Yesterday' is built on a seven measure phrase…

Jowi Taylor: Hhmm…

Music: Paul McCartney sings, 'Suddenly, I'm not half the man I used to be, there's a shadow hanging over me, oh yesterday came suddenly…'

Daniel Levitin: …and most people don't know that but they feel that there's something a little different about it …

Jowi Taylor: Yeah…

Daniel Levitin: … and that's surprising. It's McCartney experimenting with something new at a kind of implicit, subtle level, but it comes back to surprise us every single time…

Jowi Taylor: Yeah…

Music: Paul McCartney sings, 'Yesterday, love was such an easy game to play, now I need a place to hide away, oh I believe in yesterday, why she had to go I don't know, she wouldn't say, I said something wrong now I long for yesterday, yesterday, love was such an easy game to

play, now I need a place to hide away, oh I believe in yesterday, hm, hm, hm, hm, hm, hm-hm…'

Daniel Levitin: Another example of expectations is the opening to Stevie Wonder's, 'Superstition'…

Music: 'Superstition's opening drum sequence begins

Daniel Levitin: …the drum track…

Jowi Taylor: Uh huh…

Daniel Levitin: He plays drums on 'Superstition'… to set it up, he's playing something that sounds like [mimicking Stevie's drums]…

Music: short segment of the same drum sequence

Daniel Levitin: … most drummers would leave it at that, but Stevie's very innovative and very inventive… so he's playing around with the beat… he hits the cymbal a little bit harder and a little bit softer each time… he hits it in a slightly different place… and if you listen to those opening few seconds, you hear a variety – a huge variety – of nuance and subtlety there… You may not be consciously aware of it, but your brain sure is, and that's why the opening to the song is so compelling.

Jowi Taylor: Hmmm…

Music: 'Superstition' starts again…

Daniel Levitin: The brain's a giant change detector, Jowi.

Music: 'Superstition' keyboards begin

SFX: Levitin's and Chasin's words – 'auditory cortex… the frontal lobe… auditory cortex…' – are repeated in time with the music

Daniel Levitin: Music has these components that are constant across

all different musical cultures in the world… pitch is one of them, that's the difference between a low note and a high note…

Music: 'Superstition' continues with the addition of Stevie Wonder's vocals. It fades in and out

Daniel Levitin: … and you've got rhythm which is the length of a note… baaah versus ba-ba-ba …

SFX: Levitin's 'ba-ba-ba' is repeated

Daniel Levitin: … timbre is the sound of the… what makes a trumpet or a piano sound different even if you're playing the same note.

Music: 'Superstition' continues with entry of brass section

Daniel Levitin: There's also in, particularly in modern recordings of modern performances, an element of spatial location – where it's coming from… the drums are playing from one side…

SFX: Levitin's 'ba-ba-ba' heard exclusively in the left speaker, fading in and out; 'auditory cortex' heard in right speaker

Daniel Levitin: … the guitars from another. We also have harmony, the notes exist, if more than one note is playing, in relation to one another…

Music: swell of 'Superstition' then continues to fade in and out

SFX: swell of 'auditory cortex… the frontal lobe… auditory cortex…' in background, then continues to fade in and out

Daniel Levitin: In a cathedral hearing a mass, the music is swimming around in the space and around in your head, and that's an important part of it… part of that, that spatial location, is the reverberant environment – how much echo there is…

Music: 'Superstition' with reverberant FX

SFX: Levitin's words 'giant change detector' added to background, fades in and out, 'brain' SFX added

Daniel Levitin: …every culture that we know of has music… there is no culture now, or at any time in the past, that lacked it … and they all play around with all these elements.

Jimena Llopis: melody, rhythm, harmony, amplitude, pitch

SFX: echoey words – 'joy of music' 'giant change detector' 'ah, we hear it'…

SFX: layered sounds collapse into the Pärt piano piece

Daniel Levitin: There isn't a music part of the brain, music is distributed widely throughout all different parts of the brain. It's more accurate to say that every part of the brain has a music part…

Music: a few notes from the piano…

SFX: electrical zaps

Jowi Taylor: 'The Nerve' episode one.

Jowi Taylor : I went to a funeral in Bangkok. I didn't understand the words of the service, and some of the ritual offerings and the fireworks were a bit of a mystery, but I had no problem recognizing that it was a funeral from the black clothes to the friends and family crying. But the music was anything but familiar. Instead of solemn dirges, the temple ensemble played a kind of noisy exuberant music. I guess it was partly a way to speed the soul of the departed on its way and partly an antidote to everyone else's sense of loss. In that one moment, it all felt so familiar and so different. It was in one way this completely specific and local thing and at the same time it felt totally universal.

Music: Ravel's 'Boléro' begins in the background and loops…

Sandra Trehub: I'm Sandra Trehub from the University of Toronto. I'm a psychologist and I've been specializing in the study of music in infants for several years now. In adults, we knew that people are very interested in music. They spend much of their time. They spend a lot of money, you know to, be connected with music and that it is an important way that people manipulate their moods… psych themselves up for things…

Music: opening bars to Wagner's 'Flight of the Valkyries' mixed over Ravel

Sandra Trehub: … soothe themselves, remember people by, you know, the songs they knew…

Music: echoey first chord of the chorus of the Beatles 'Eleanor Rigby' plays in the background over Ravel

Sandra Trehub: …these nostalgic feelings about certain eras in your life that are tied to music.

Music: echoey first note of 'Over the Rainbow' mixed over Ravel

Sandra Trehub: There was every reason to believe that all that interest in music just resulted from our history of listening to it and even that the emotional connections would come from that – the possibility that we might start out with some dispositions for music – there wasn't any notion that that would be likely at the time.

Jowi Taylor: So you didn't set out thinking that you…

Sandra Trehub: Not at all…

Jowi Taylor: …were going to find something?

Music: Ravel continues with entry of melody

Sandra Trehub: Originally, I would just take, really, a random set of tones, and just manipulate them in different ways and I was thinking first about the contour – how they go up and down – 'cause I know when mothers speak to

babies, they emphasize the pitch contours in their speech. You know, so no one just says, you know, 'Hi, baby,' it's [in a voice with lots of pitch highs and lows] "Hi, baby! What are you doing?' and so on. I was looking at those kinds of things – pitch contours – never thinking that the precise notes mattered or the intervals… But, you know, out of curiosity, I decided to see, well, what if you actually follow the rules of legitimate musical systems – what would happen? And suddenly I found that babies were remembering those tunes better than others. So as soon as you started violating the rules, or doing things that were impossible in any musical culture, at something that didn't sound good to us, but we'd think, 'ah, it's just unfamiliar,' but it didn't make sense to babies either - in the sense that they couldn't remember it.

Jowi Taylor: So at that point you started looking for universals?

Sandra Trehub: Yeah…

Music: Ravel continues with rhythm looped; echoey first note of 'Over the Rainbow' mixed over music; Ravel loop continues

Sandra Trehub: I decided to look at infants and look at the things that they could do, and the things that were important to them in music and try and see whether those features were common in musics of the world. And it turns out, that they are.

Music: 'Over the Rainbow' first note mixed over Ravel

Daniel Levitin: The octave appears to be a musical universal – that is two notes that stand in a relationship to one another that one of them is twice the frequency of the other…

Music: The opening word to 'Over the Rainbow' echoing in the background

Daniel Levitin: We see it in our scale, [singing the scale] ba-da-da-da-da-da-da-da, [singing the octave] ba-da.

Music: The opening word to ‘Over the Rainbow’ echoing in the background

Daniel Levitin: The low note and the high note are given the same name in the scale. We might call them both ‘C’ – [sings scale] C, D, E, F, G, A, B, C… [singing the octave] ah-ah…[music: first word of ‘Over the Rainbow’] The same note name is given in recognition of the fact that there is something perceptually in common that those two notes share…

Music: Judy Garland sings the first bars of “Over the Rainbow (Ravel loop ends)

Sandra Trehub: Pitch [SFX: Jimena Llopis repeats ‘Pitch’] is related to frequency; frequency is what you measure – pitch is the sensation that you have, so when we hear things that sound an octave apart, like the first two notes of ‘Somewhere Over the Rainbow’…

Music: First two notes of ‘Over the Rainbow’

Sandra Trehub: If you look at the frequencies, every time you have an octave, you have a doubling of the frequency… so you have a ratio of two to one – a very simple ratio.

Music: Judy continues singing in the background

Daniel Levitin: Our brains evolved in the physical world and there are certain physical regularities in the world. When objects vibrate, they tend to vibrate in several modes at once, whether you’re talking about, you know, a drum or a hollowed out bone, you pluck a string, you’re getting multiple modes of vibration that tend to have these simple integer ratio relationships so the octave comes out that and our appreciation of it is wired into us because for tens of thousands of years our brains heard sounds that had these particular properties…

Music: an echoey ‘Somewhere’ from Judy… fades off… is replaced by loop from Ravel’s Boléro …

Sandra Trehub: In addition to the octave, you have the perfect fifth…

Music: repeated piano note SFX as before, playing perfect fifth and continuing in background, mixed over Ravel

Sandra Trehub: …which seems to be present in every culture. Maybe if you measure it instrumentally, it may be off slightly, but in terms of listeners, they can't hear the difference. So that seems to be an important anchor. So you have these basic building blocks and then cultures fill things in in different ways…

Music: Melody resumes in Ravel with classical Indian sarod music layered over it

Daniel Levitin: One thing about pitch is that every musical system we know of has a limited number of pitches, not an unlimited number, and it tends to be seven to twelve pitches that they use. Our own scale has twelve notes, the chromatic scale, but we tend to use seven at a time, the so-called major scale or minor scale and this probably has something to do with the limits of memory resolution…

Jimena Llopis: Pitch…

Music: Ravel loop ends; the von Trapp children and Maria sing, 'So – a needle pulling thread, la – a note to follow so, ti – a drink with jam and bread, …' plays in background mixed over sarod music; sarod music ends, Do Re Mi continues

Sandra Trehub: If we think about the major scale in music, because that's highly over-learned people seem to think that it goes in equal steps, but if you think very closely or if you look at the piano you see that you don't have a black note between every two white notes, there are a couple of places where you don't – between your B and C or 'ti-do', that's really just a semi-tone…

Music: Julie Andrews sings, '…that will bring us back to do – do, re, mi, fa, so, la, ti, do – so – do!

Music: repeated piano note SFX…

Sandra Trehub: …and no scale in the world has just equal distances between all the steps – that's thought to be of psychological importance in terms of helping us remember things. And we actually tested infants and when we used invented scales that had equal intervals, babies weren't able to notice changes in that context, and when we used scales – also invented – that had this principle of unequal steps, they were able to do so. So, there are certain principles of even how you fill in the notes of a melody… there's room for arbitrariness, but it's not completely arbitrary, and what some musicologists think, is that this notion of unequal scale steps, helps us find our place in a melody.

Jowi Taylor: They're like landmarks and stabilizers…

Sandra Trehub: Uh-hmm…

Music: Piano SFX continue; gamelan music begins over top and continues

Jowi Taylor: I'm picturing putting an infant in a room and – a Western, European infant – they're enjoying the 'Barney' melody, and then you put on some gamelan music, and the suggestion is that they would have no trouble absorbing the rules of the gamelan…

Sandra Trehub: Right... Now we have to distinguish between melodies and, you know, when you're thinking about gamelan, a big part of that sound for us is the instrumentation… so, if you were to take away some of those metal instruments that have a particular quality to the sound, it wouldn't have the sound you normally associate with a gamelan.

SFX: Gamelan music processed

Sandra Trehub: And there was a researcher that did use scales that are used in Indonesian music with infants and, you know, with six month old infants, you know, it made no difference to them.

SFX: Piano note SFX and gamelan mix returns

Sandra Trehub: So, it's not a question of simply of the notes, you know, but part of what we learn in every culture is certain instruments become familiar with their sound qualities.

SFX: Piano note SFX continue; Levitin's voice says "timbre" processed

Daniel Levitin: We live in an age where – especially in popular music… when we listen to Joni Mitchell or to Bruce Springsteen or to Arcade Fire, we are developing a connection with the artist through their songs and through their voice, and the timbre of their voice is unique…

SFX: echoey fragment of Paul McCartney's voice

Jowi Taylor: I don't know if you remember the little experiment you did with the crowd at the author's festival with the… particular…

Daniel Levitin; Yes!

Jowi Taylor: …opening chord? Can you describe what you did at that … because that was *amazing*.

Daniel Levitin: Well, I played five hundred milliseconds – that's half a second – of one note of a well-known song…

Music: 1/2 a second of 'Eleanor Rigby's first note plays…

Daniel Levitin: …without the melody emerging because it's only one note, no rhythm there because, again, it's not even one note…

Music: 1/2 a second of 'Eleanor Rigby's first note plays…

Daniel Levitin: …but almost everyone in the audience recognized what the piece was. It's obviously 'Eleanor Rigby' – not everyone recognized it as 'Eleanor Rigby' – but almost everybody recognized it as the Beatles – it's so distinctive… and it's because the brain is so exquisitely sensitive to timbre that we're able to do that… It's no

surprise the brain would be that sensitive to timbre because it serves an important evolutionary function. Again, in our cave-dwelling past, when the sun would go down, you couldn't see people… You'd need to be able to recognize somebody by their voice, and moreover, you'd need to be able to tell whether they were angry with you [laughs] or happy with you as… you know by the sound of their voice… and all of that is really about timbre.

Music: Ravel fades up in background and continues

Sandra Trehub: I must say that I was stunned by what I learned from infants about music… it really started me thinking about music – what it could do for us – the fact that we're able to learn what we can about it and the fact that none of that would be possible if we didn't start out with a fundamental interest in it… I was going to test babies with foreign materials of different kinds and make contacts with ethnomusicologists who specialized in different musical systems. And asked them if they would find some simple materials for me, such that I could use them with babies – they would have to go into whatever cultural group they were studying and that simplification would have to satisfy people in that culture that it was really, you know, Indonesian, …or from this part of Africa, you know whatever it was, and when they brought back those materials to me it was terribly disappointing because they no longer sounded like [laughs] anything that was foreign… Once you got into something simple, it was all sounding pretty similar…

Jowi Taylor: Amazing… So that actually goes back to what you were saying earlier about timbre and ornamentation being where the culture…

Music/SFX: Repeated piano note and Ravel processed

Sandra Trehub: Yes…

Jowi Taylor: …the choices, the preferences really come in…

Sandra Trehub: Right, so you start from a common set and then you go somewhere with it… you develop it in ways that suit the culture… so, you know, I would argue that there's more that's common across musical systems than is the case across languages.

Jowi Taylor: [voice distorted] 'The Nerve' episode one.

SFX: [electrical zaps and 'brain' SFX]

Jowi Taylor : One of my favourite painters is Mark Rothko. His canvases are those big ones with a field of colour that runs right to the edge and then these big rectangular shapes, sometimes one, or two, or three, that are just these blocks of colour, sometimes not that different from the background colour. Well, I can stand in front of one of those paintings at the AlBright-Knox Gallery for ages and just feel them – it's like I'm actually plugged into them some how. If the top bar is a kind of a warm orange, I feel warm in my chest. If the bottom block is a cold black, I get a chill in my gut. And I've always said that for me, Rothko's paintings are like music. I don't just see them, I feel them, I hear them.

Music: Ravel comes in at full volume…

Marshall Chasin: Loud sound is enjoyable…

Music: Snippet from Tchaikovsky's 1812 Overture

Marshall Chasin: It's more a visceral sort of thing…

Music: a couple of bars of the Rolling Stones' 'Satisfaction' plays

Music: Ravel again in background

Marshall Chasin: When rock-and-rollers say the music has to be loud, they are correct…

Music: Ravel melody enters at full volume, then fades to background

Jowi Taylor: Do you have a particular physical reaction to it?

Ellen Dissanayake: Yes, I do… I do.

Jowi Taylor: What is it?

Ellen Dissanayake: It's on my… not on the back of my neck… the hair on my arms… [laughs]

Suzanne Cusick: Music, much more than any medium that might engage another human being for life, like a picture … Music makes the cells of our bodies vibrate. It stimulates the surface of our skin. It makes us, in a way, feel, literally, in sympathetic vibration with the environment around us. It surrounds us completely… That's, of course, the reason why we find joy in it.

Music: Ravel continues…

Marshall Chasin: Loud sound is enjoyable. It's as simple as that. And as an audiologist, I'm sometimes torn between two extremes: too loud and it can be potentially damaging to your hearing, too soft and no one's going to listen to it.

Jowi Taylor: What about bass? Where…we're all very attracted to bass too…

Marshall Chasin: Bass is actually very good, and again, it's more a visceral sort of thing…

Music: bass part of Ravel plucked on cello emphasized as rest of orchestra is diminished… then fades into background

Marshall Chasin: Loudness is given to us by our bass response – the more bass there is, the louder it seems to be but, in fact, if you can really turn up the bass, after a while you can feel it, you don't have to hear it anymore. You can sit on a loudspeaker, or put your hand on a loudspeaker and it has a significantly good bass response, you won't feel it… and it's this visceral bass feeling that also adds to the whole hearing mechanism.

Music: Ravel swells again… then fades into background

Bruce Cockburn: I think that comes down to rhythm. I think that if you listen to some of the simplest music from cultures that obviously existed from pre-history into our notion of history, you hear the heartbeat right in the music… [mimicking heartbeat] ba-dum, ba-dum… it's a rhythm that shows up in a lot of native American music for instance…

SFX: Leviton's 'ba-ba-ba-bup' and Cockburn's 'ba-dum' are repeated… fade in and out

Daniel Levitin: What we find rewarding about music is…

Music: Key changes in Ravel's Boléro

Ellen Dissanayake: First of all, loudness, and then a kind of very regular kind of beat… I think that it just kind of pulls out all the plugs…

Music: Ravel continues with vocal FX mixed in…

Jimena Llopis: So if you can get the right combination…

Music: Ravel continues…

Jimena Llopis: …brightness, harmony, pitch…

Music: Ravel continues…

man: …giant change detector…

Music: Ravel continues…

Jimena Llopis: …brightness, pitch…

Music: Ravel continues…

man: ba-ba-ba-bup, ba-ba-ba-bup…

Music: Ravel continues…

Jimena Llopis: …pitch, harmony …

Music: Ravel continues…

man: ba-ba-ba-bup, ba-ba-ba-bup…

Music: Ravel continues…

Jimena Llopis: …pitch, harmony …

Music: Ravel continues…

man: ba-ba-ba-bup, ba-ba-ba-bup…

Music: Ravel continues…

Jimena Llopis: …pitch…

Music: Ravel ends; replaced by Pärt piano music mixed with 'brain' SFX

David Harrington: …It's um… It's a mystery.

Music/SFX: fades out

Jowi Taylor: You've been listening to 'The Nerve.'

SFX: 'Brain' SFX

Jowi Taylor: In this episode, you heard the voices of [each says in their own voice:] Bruce Cockburn, Jimena Llopis, Marshall Chasin, Ellen Dissanayake, Larry Kirkegaard, Suzanne Cusick, David Harrington, Sandra Trehub, Daniel Levitin… [Taylor's voice again:] and the music of Rogers and Hammerstein and Julie Andrews, Arvo Pärt, Antonin Dvorak, Ludwig van Beethoven, Stevie Wonder, Arnold Schoenberg, Radiohead, the Beatles, Maurice Ravel, Judy Garland. Amjad Ali Khan, the Royal Jagjakarta Palace Gamelan, Peter Tchaikovsky, and the Rolling Stones… I'm Jowi Taylor… that's the end of this 'Nerve.' Thanks for listening.

Music: 'The Nerve' theme begins

Patti Schmidt: That was Episode One of ‘The Nerve,’ a six part series about music and the human experience. ‘The Nerve’ is brought to you by host Jowi Taylor, with production and sound design by Paolo Pietropaolo and Chris Brookes… On Episode Two, we’ll look at music and evolution and ask why music even exists in the first place. ‘Inside the Music’ is heard Saturdays right after ‘I Hear Music,’ and Sundays at noon on Radio 2 as well as Sunday night on Radio 1 at 8:00 p.m., half an hour later in Newfoundland. For more information on this show, go to our website at cbc dot ca slash inside the music. Stay tuned for more great programming on CBC Radio 1 and 2. I’m Patti Schmidt and this has been ‘Inside the Music.’ Thanks for listening.