[Your Complex Brain theme music]

00:03 Farrah
I think a lot of the stress that I've dealt with or felt over the years is-- I'm going to say it's an impossible situation that many people are in, where you can't possibly manage every single thing that you're told you're supposed to be able to manage.

00:21 Heather
This is Your Complex Brain, a podcast all about the brain, the diseases that impact it, and the path to finding cures. I'm your host, Heather Sherman, and I have the great pleasure of working alongside the team at the Krembil Brain Institute in Toronto, Canada, a leader in brain research and patient care. In each episode, we'll take you behind the scenes into our clinics and research labs to meet the game changers of the future. We'll also empower you with the latest research to help you take charge of your own health. You'll hear directly from patients who are living with brain disease as well as their loved ones and the care teams who support them. Join us on a journey to unravel the mystery of your complex brain. [theme music continues then fades out]

01:11 News Reporter 1
[driving electronic music] Americans are now reporting the highest stress levels since the pandemic began.

01:16 News Reporter 2
A new survey, out from Angus Reid today, reflects just how seriously Canadians are looking at the economy – the vast majority, almost all Canadians making changes, cutting back.

01:29 News Reporter 3
Growing stress among unpaid caregivers is an alarming reality. A new Ontario study of 110,000 caregivers found a third experienced distress, anger, or depression.

01:45 Heather
[light, bubbly electronic music] In a world that's becoming more and more divisive, there's one thing we can all agree on. As a society, we are stressed out. Whether it's financial pressures, family or work obligations, or even just finding time for yourself in a never-ending tornado of to-do lists, stress is everywhere, and it's not going away.

We often talk about the physiology of stress, how it affects us physically and mentally, but today we're going to delve much deeper to talk about the science of stress, what's actually happening in our brain and our body when the stress response is activated, and how these insights could lead to new approaches and therapies for treating disease.

Before we get into that, though, I'd like you to meet a friend of mine and a work colleague, Farrah Schwartz, who has kindly agreed to share her own experience of living with stress. [light, bubbly electronic music continues then fades out]

02:54 Farrah
[gentle electronic music] My name is Farrah Schwartz. I'm the Manager of Patient Education and Engagement at UHN. What we do in patient education and engagement is we try to help people deliver health-literate resources, and we provide training and coaching to help TeamUHN engage patients more

easily. We're also doing really exciting work around patient engagement within organizational improvement. That's a big part of our mandate. We're also looking at equity and inclusion; that involves partnering with equity-seeking groups to ensure that our health information is inclusive and unstigmatizing. You can sort of see people thinking about experience like, "Oh, here's a pillow. Would you like a blanket," or, you know, "Would you like a drink with your order?" kind of thing, and it's not that. It's really about, "Are they able to get where they need to go? How do they feel when they're coming into the hospital? Do they feel heard? Do they feel that their decisions were actually factored in? Did they feel confident going home that they would be safe?"

Those are all really critical things, so all of those things have been driving this work for a long time, and we've been doing it for a long time, and we've always known how important it was, but then the pandemic came along, and so much of this information was as critical as it's ever been, especially in a hospital situation at UHN. When the pandemic hit, we really had to focus on, "How are people still getting care? How are they actually getting through the door and not going to get sick?" and by having a focus at the organizational level, we were really able to keep patient experience and patient engagement as a priority. [gentle electronic music fades out]

[light, upbeat guitar music] Stress has been a part of my life since before the pandemic. You know, everyone has stress but, for me, I think I've had some times where I felt more acute stress and have had to deal with and navigate that to negotiate my life. I have two kids, so now they're 12 and 15. They're great kids, and it's challenging being a parent. I don't think anyone will disagree. And then, you know, I work at a full-time job. I'm actually really lucky. I work four days a week, and that's something that I negotiated when I was coming back after having my second child. Reflecting now, and knowing what I now know as a leader, a woman, someone, you know, just really working in this environment, I was able to take care of some of those needs, but it was difficult.

So, coming into the pandemic, I'd gotten through a lot of stressful times already, and I knew myself fairly well. A lot of the maybe doubts that I'd had, or worries and fears, they were pretty real in the pandemic. They were pretty concrete and solid, but I think, because I'd dealt with them before, there was a little bit of protection I had from that, [light, upbeat guitar music fades out] so I felt a lot of stress about the world situation, as did a lot of people watching what was unfolding, and I was able to go and actually do something, and it was very demanding, but it occupied my brain a lot.

[light electronic music] I think a lot of the stress that I've dealt with or felt over the years is-- I'm going to say it's an impossible situation that many people are in, where we're trying to do everything and manage everything and it's not possible. We don't have enough hours in the day and I didn't realize it back then.

You can't possibly manage every single thing that you're told you're supposed to be able to manage. As a parent, and a partner, and a person who works and also manages a team of people, I've had to understand I'm not perfect. I've always been someone who second guesses myself. I have a really strong inner critic, and so when these things come up, or when there's too much or I have doubts about actually being successful in what I want to do, like being a parent and having the time to do certain things, or if they don't get their homework done, I felt guilt that their homework's not done, and taking it upon myself so, you know, when we have all of these things that we're working on, and we have ideas about how it's supposed to be, it doesn't always work out that way. [light electronic music fades out]

The dynamics at home would often cause a lot of stress for me. There were periods of time where I think it was just so much, and I often felt very guilty because I would go to work and feel happier, and then I would come home and kind of just blow sometimes, or not feel like I was being the parent I wanted to be.

[gentle, upbeat electronic music] I do think that there's a lot that people have to carry and that they don't necessarily realize the impact of having to carry so many multiple things, especially if there are social expectations that we just do those things, and then there's no extra room or recognition given to that. For me, I think one of the first things that I've noticed when I get stressed is my mood. I get maybe irritable or emotional. Like, sometimes your mood is affecting all of your interactions, and then it does cause more stress so, if I'm dwelling in what happened when I have this interaction that I perceived in a certain way, like, it's going to make me more stressed.

So, for me, it's been a really helpful thing trying to tune into that mood. If I'm feeling a certain way, like I'm just feeling, like, "Ugh," I try to recognize that now and be like, "I'm feeling really stressed. Like, it's not even 9 o'clock and I already feel like the world is beating down my door and I haven't done enough today. So, what's that telling me?" It's a strategy that I think has also really helped-- is just to try to recognize how I'm feeling and how that might influence other things, and then just breathe through it.

Being able to look back and say, you know, "I felt this way when I was a younger parent," or, "This was how I felt then," I can also recognize how much I've learned about myself [gentle, upbeat eletronic music fades out] and how far I've come with, you know, some of that self-criticism, the guilt. [hip-hop electronic music] I found it really helpful, at times, to just stop and say, like, "This is hard." If I had a friend who had this happen this week, I would be like, "What can we do for you? How can we help?" so I've really tried to apply that same empathy for myself.

Gratitude has been really helpful for me, as well. Like, at the beginning of the pandemic, I felt really grateful to have a home that I could be in and that I could feel safe in. I also could feel grateful for going outside and just taking a walk and having that air to breathe, or even just sometimes, now, if I'm feeling stressed or I'm tired, "I'm really enjoying this cup of tea right now," or, "I'm really grateful to be able to have, you know, a plant on my office desk at home that I like to look at every day." For me, I found that it's just those small little moments, those small little things that my brain can hook onto and say, "This is a good thing. This is a thing you're doing for yourself," or, "This is something you're enjoying." It's really important, especially when I can't quite settle the stress in my mind. [hip-hop electronic music fades out]

[delicate, energetic electronic music] And then, the other thing that I think has been really important, and especially at the beginning of the pandemic, was I really am so grateful for my job because I love what I do and it's exciting and it's interesting, and I feel like I'm making a real difference at the patient education level, as well as with the leadership team in patient experience, there was such a sense of support and cohesion and really just friendship. The bonding nature of the stress really brought us together and allowed us to get through the work as well, in a way that was easier because we could relate to each other's experiences, we could respect how we were all contributing, and I think, ultimately, it built up our trust and made our trust there with each other, which was really critical at a tough time.

I hope people take away from my story that stress is very normal and it looks different sometimes than you expect, but it's something that we all have to live with and we can get through. Sharing my story, I

know that there are a lot of things that are different from what others experience, but I also think that there's a common nature to stress that can be there. [delicate, energetic electronic music] If there's any small tip or opportunity to help address stress that I've provided, I hope that it could help someone else.

11:02 Heather
[gentle electronic music] Our guest today is Dr. Jaideep Bains, Director of the Krembil Research Institute, and Senior Scientist at the Krembil Brain Institute, part of University Health Network in Toronto.

Dr. Bains is a world-renowned neuroscientist who studies the impact of stress on the brain. Dr. Bains, thank you so much for joining us today on the podcast.

11:24 Dr. Bains
It's my pleasure to be here, Heather.

11:26 Heather
Well, it's great to have you here. Let's jump right in because this is such an intriguing topic. So, what exactly is stress? What do we know about what's happening in the brain to trigger this stress response?

11:39 Dr. Bains
Yeah, so stress is a complex set of physiological responses that occur in response to challenges. I say that very deliberately in kind of a very broad way, because "challenges" can mean many things. Challenges can be external challenges, threats that we face. They may also be challenges that are internal challenges, for example, you might have an infection. There might be inflammation, and so your body has all these mechanisms in place to help you manage these challenges. And so, when you're under duress or under stress, a number of different pathways in your body are initiated. This includes a number of pathways in your brain which help regulate your behaviour, which control your breathing and your heart rate, which control your general level of arousal. They also trigger the release of hormones. Like, cortisol is the stress hormone that we think about a lot, but also hormones like adrenaline, which is part of the classic fight or flight response that we see associated with stress.

12:43 Heather
Interesting. Well, you mentioned a little bit about it, but I'm really curious about the different kinds of factors that can trigger stress. So, for example, is there a difference between when somebody feels physically threatened versus when they might experience some sort of a psychological or internal stressor, like, maybe they have multiple exams on the same day, or they've got public speaking to do, something like that?

13:04 Dr. Bains
There are elements of the stress response that are activated or recruited regardless of what the actual stressor is, whether the stressor is external threats, like, because you alluded to, you're physically threatened, or whether it's something that we internally generate, you know, this kind of forward-looking idea that there might be a bad outcome, let's say when you're writing an exam. And so, although there are some neural pathways that are distinct for those two, obviously, you wouldn't need to generate a rapid motor response as you're thinking about writing your exam, like you do when you're trying to evade a threat, but many of the other pathways, for example, the release of cortisol, occur in both cases.

13:43 Heather

So, how long does the stress response usually last?

13:46 Dr. Bains
It lasts for the duration of the stressor, but then it also persists for some time after that. So, in response to a stress, your brain pathways engage very, very quickly, but the cortisol release happens slowly. So, let's say you have a threatening event which occurs over the course of five or 10 minutes, the cortisol levels may not rise for another 30 minutes, and then may stick around for about another hour or so. And so, what that cortisol is doing is, it's not directly responding or helping you respond to the threat in front of you. What it's doing is it's liberating metabolic stores so that you can kind of recover from the stress.

But, the cortisol also has a number of effects on the brain. It activates different brain regions to help you remember what happened during the stress, for example, so that you can respond more effectively the next time, [mellow guitar and electronic music] and the cortisol also helps to shut off your brain stress response, once the stressor is not there anymore.

14:45 Heather
Interesting. Okay. Well, I've heard you speak a lot about the perception of control and how that can impact somebody's response to stress. Can you tell us a little bit more about that?

14:54 Dr. Bains
Yeah. So, this is a really interesting area in the stress field, and a number of different labs around the world have thought about this quite a bit and the idea is that although the intensity and the duration of a particular stressor are both important factors, it turns out they're not the key factors in determining the consequences of stress on your brain once the stress is over. For that, it turns out that the ability to perceive some type of control over the outcome during a stressful event is really, really important. So, for example, if individuals perceive, like, they have strong control over the outcome and that they'll be able to manage and get through the stress, then stress seems to have far fewer negative consequences down the road. [mellow guitar and electronic music fades out]

On the opposite side, if individuals feel like they have a complete absence of control or don't have any say in what the outcome is going to be on the stress, then they have much more of a negative outcome later on, after stress.

15:57 Heather
And what are some examples of some of the consequences that someone might experience?

16:02 Dr. Bains
Stress has been implicated in the emergence of different mental health conditions, for example, the development of anxiety disorders, depression have all been linked to either repeated stress or to very intensely stressful events in your life.

16:17 Heather
Stress isn't all bad though, right? I mean, we need stress in our lives, don't we?

16:21 Dr. Bains
Yeah, absolutely. The stress response, first and foremost, is there to help you survive, right? So, every organism that has some type of a stress response, it's there, it's been evolutionarily conserved so that you can respond to a threat, you can respond to challenges, you can maintain your internal homeostasis

or your internal state, right? So that's why the stress response exists. Without it, we wouldn't be able to deal with any kind of challenges in our environment.

16:49 Heather
And can we actually build up a resilience to stress? For example, I'm thinking about people who might have, you know, stressful jobs working in an ER. What have we learned about how people can adapt to stress and sort of manage it over time?

17:02 Dr. Bains
Yeah, this is really a challenge, right? This is one of the things that we would all like to get to is to build a more resilient population, so that we take stresses and we use the stress in a positive way to make us able to cope with similar or different stresses better in the future. And so, this is where the idea around controllability of stress comes in. If you can manage to figure out strategies where you have control or even the perception of control over the stress, and I think that's really important that you perceive that you have control. You may not actually have control, but if you can convince yourself that you have control during stressful events, then that seems to transfer over to other events that are completely unrelated, and you start to exhibit more kind of take-charge behaviours to deal with the stress, rather than having the stress fall on you and you are just responding to the stress and you feel helpless.

17:59 Heather
I'm always interested in how some people appear to adapt a little more easily to stressful situations than others. Could it be that people are actually wired differently in their brain circuitry?

18:09 Dr. Bains
It's a hard question to answer. I think it's one of those questions that comes down to some nature and some nurture, right? There's a really rich literature on this that early life experiences can really set the table for how you respond later in life to stressors. Facing challenges and managing to get through those challenges with success probably sets you up for managing difficult events later in life.

The other really critical window, of course, for us as humans is during adolescence. Adolescence is a really important time because it opens up a kind of critical window of development again, and many people argue that adolescence and what happens during adolescence kind of changes the slope of your trajectory as you move forward into adulthood. And so, those kind of critical periods—early life and adolescence—are really, really important. That's not to say that, you know, there are individuals who have a genetic predisposition to handling stress better. If that's the case, then there's probably not a lot we could do about that, but I think the ability to modify neural circuits to set you up better to manage stress, that's where the real hope lies.

19:18 Heather
Okay. [gentle electronic music] Well, you've given me hope because I've got two teenagers, so I'm going to get working on their resilience, and I guess this is as much a parenting podcast as it is a science podcast. [Dr. Bains laughs] I also wanted to ask you about your research into stress being contagious – so fascinating. I'm dying to know the reaction you get from people when they hear this is what you study.

19:38 Dr. Bains
I get two reactions, usually. One is they go, "Oh, really?" and they're really surprised, [Heather laughs] and then they start thinking about, "Oh, my god. Does that mean that hanging out with stressed out

people is going to stress me out?" and they start thinking about their lives. And then, the other reaction I get is people nod and they say, "Well, of course. Yes, I know that." Both are great reactions, actually.

20:01 Heather
Yea, and I'm nodding along with you right now. [chuckles]

10:04 Dr. Bains
Yes. [laughs]

20:05 Heather
So, let's dive into that a little bit. How is stress contagious? What are you learning in your research?

20:10 Dr. Bains
It's a really interesting thing, you know? With a lot of physiological conditions, we think of them as really about the individual, right? So, if I have some type of illness, it's about me. It doesn't really affect you. The way that we study the body, the way that we study the brain, we really study at the level of the individual. But, you know, it turns out that things like stress, and even if I go beyond stress, let's call them kind of negative internal states – a state where an organism is under threat, so those types of states trigger the stress response, like we've already talked about, but as part of that stress response, we and other organisms also send out signals, and those signals are designed to alert others, to attract others to you, and by coming towards you, what happens is others gain information about what you may have experienced. So, that's a benefit, so that means that another individual doesn't have to be exposed to a threat, yet benefits from your experience by learning about it. [gentle electronic music fades out] But, what they also do is they probably provide some type of support, a way to help you buffer your stress.

And so, evolution has worked this out over millions of years, and we are the beneficiaries of it. And it's not just humans. You see these types of behaviours—stress transmission—in primates. You see this in your pets, I'm sure. And actually, dogs are very good at detecting stress in human beings. There have been a few studies done on this, so that's kind of another fascinating cross-species idea that dogs can detect stress in humans.

21:45 Heather
Well, I sometimes think that my dogs are more attuned to my stress than my family.

21:50 Dr. Bains
Yes, they probably are. [laughs] [Heather laughs] So, when you think about that, of course, you start to think about, "Well, how is the stress transmitted?" and we know dogs spend a lot of their time, for example, sniffing around, right? And so, in humans and in all of these other species, one of the ways stress is transmitted is through the release of chemicals from our skin, probably from our sweat glands. We're not sure if it's a particular sweat gland located in a particular area of our body, but we know, for sure, from the sweat glands in our armpits, we emit these stress signals and these stress signals, when detected by others, cause increases or changes in their heart rate and blood pressure, consistent with what you might see in a stress response.

A number of labs have been looking at stress transmission in humans. One of the more interesting experiments that I've seen has been done by a lab in Israel. The investigator's name is Noam Sobel, and they do this really beautiful, thought-provoking experiment. So, what they did was they extracted sweat

from individuals in one of two groups. In one group, individuals had exercised, and the other group had gone skydiving. And so, obviously, you could imagine the skydivers are more stressed, jumping out of an airplane than people who just exercise. And so, if you take that sweat or that extract and you put it on a towel and you expose individuals who are unaware of what the other people did to the towel, people can detect the difference in the smell between the two things. And so, they can say, "Oh, this thing smells different than that thing," and it's pretty reliable that people could detect the difference when it's sweat from an intense experience like skydiving – stressful versus exercise.

So, then what the investigators did was they took that sweat and put it on towels in very, very low concentrations, at a concentration that individuals couldn't consciously perceive it. And so, when they put the towel in front of these people, they asked, "Do you smell anything?" and they said, "Well, no." Or they put it in through the air circulation. "Do you smell anything?" "No." But, what they found was that, if people were exposed to the scent from the skydivers—the stressful scent—they showed an autonomic arousal, so they showed a change in their respiration rate, they showed a change in their breathing, their heart rate, and they also started to make more errors in cognitive tasks when they were exposed to the smell of stress, even though they weren't aware that they were smelling it.

[gentle electronic music] So, that's really, really interesting, and so that ties in really nicely to what is emerging about how we understand our olfactory system, so the cells in our nose and the area of the brain that processes that information, how that links to different parts of the brain.

24:36 Heather
Okay, so when I'm feeling stressed, I mean, I know it always helps me to visit with friends, maybe catch up over dinner. How important is that social interaction?

24:45 Dr. Bains
Social interactions are really, really important. I mean, there has been an extensive amount of work done on the importance of positive social interactions. You know, social interactions aren't always positive – positive social interactions, in having benefits for mental health in general, but also in helping to mitigate or decrease the level of stress that you feel. So, that's really, really important. I think the other side of social interactions that is still a really emerging field and an exciting field is the consequences of social interactions on the long-term impact of stress, not just that they buffer the immediate stress, but they may help to erase or edit some of the changes that stress is having on your brain. [gentle electronic music fades out]

25:34 Heather
You'd think that social interaction might actually be the cause of stress for some people, especially those who might be dealing with anxiety, which is so prevalent.

25:42 Dr. Bains
I think the type of social interaction is very, very important. And so, in this case, it's very difficult to just make a blanket statement and or provide a recipe for the type of social interaction. I think it's going to be very dependent on the individual.

25:56 Heather
It almost makes you wonder about the whole idea of surrounding yourself with, you know, positive people versus negative people, and the impact of the stress, both ways.

26:04 Dr. Bains
Yeah, that's absolutely correct, actually. Ideally, it seems that if you can surround yourself with positive people, that's probably a great thing. Whether those positive people [chuckling lightly] think you are also a positive person, I don't know. [both chuckle]

26:19 Heather
Well, what about gender differences when it comes to this whole idea of social interaction? How does that factor in?

26:23 Dr. Bains
There are some really interesting thoughts around this, going back to even some early psychology work, when psychologists looked at children, and they realized that girls and boys appear to have different strategies when they socialize, and some of these studies indicated that girls, preschool, early school, tended to use a strategy which psychologists label, "tend and befriend" strategy, so they would be very good at congregating in groups, forming friendships and alliances that way. Boys tended not to do the same thing. That idea got us thinking about whether that social interaction, that group structure, those dynamics, specifically in females, may be beneficial to stress. And so, what some of our research has shown is that the effects of stress, the long-term consequences of stress on neural circuits can be erased by social interactions in females, but we don't see that in males. And so, there's some sex specificity baked into the interactions and how they impact neural architecture, and it's something that we don't really know a lot about right now, but I think it's really a fascinating area.

The second part of that, of course, is then how are males buffering their stress? What is it that they need if social interactions are not working for them? And again, it's something that's really an open question and really is at the kind of cutting edge of the things we're trying to figure out.

27:47 Heather
Okay, so this is so fascinating. So, just to clarify, you're saying that, basically, females appear to benefit more from this whole idea of social interaction in terms of the impact that it has on decreasing their stress, but it doesn't have the same effect for males?

28:01 Dr. Bains
Correct. That's exactly right. Yeah.

28:03 Heather
So, is the idea then that, if we can better understand the connections and the science behind stress, that maybe it could lead to new approaches and better therapies?

28:11 Dr. Bains
Yeah, that's exactly right, and the idea is that, if we begin to understand the types of behaviours that are important in erasing some of the effects of stress, if we can begin to tease apart the kind of cellular and biochemical substrates, the signals in the brain that are helping specific cells hold on to information about the stress, if we can figure out what those are, can we begin to target those in a kind of combinatorial way that combines behavioural therapies, perhaps, with pharmacological therapies to help mitigate some of the effects of stress? [gentle electronic music]

28:47 Heather

Especially with the increase in mental health issues that we're seeing, it really seems like a critical time for new approaches and new therapies.

28:54 Dr. Bains
It absolutely is, yeah. There's this kind of emerging idea that we can start to change brain function through things like neuromodulation, so this is a fascinating idea. It's been done for other neurological diseases. Parkinson's is the best one, that a lot of the work has been done on, but neuromodulation now, in which you can stimulate, you know, areas of the brain from outside, using perhaps something like a focused ultrasound approach, neuromodulation is now also being used to treat disorders like depression, and so there's a lot that we've learned from basic research that has gone on to try to understand how different patterns of activity can modify brain circuits, lead to permanent changes, and now our clinicians are starting to leverage this to try to treat people. [gentle electronic music fades out]

29:52 Dr. Curtis
[relaxing, atmospheric music] I'm Dr. Kathryn Curtis and I'm a Clinical Psychologist at the Toronto Western Hospital at the University Health Network, at the Comprehensive Integrated Pain Program. My research is in the area of mindfulness and yoga, and I'm also a long-term student of eastern philosophy and Vedic traditions.

Many of the patients in the Comprehensive Integrated Pain Program are living with, oftentimes, moderate to severe chronic pain from a variety of different diseases or accidents or injuries and, along with that chronic pain, comes many life stressors – maybe the inability to work, financial stress, family stress, and other issues that can accompany the pain, like mental health conditions and living situations.

Stress can impact our lives in a huge amount of ways. We know that stress can impact pretty much every bodily system and virtually every physiological process in the body, and so, if we can carve out even a few minutes a day to be combating stress through a variety of different mind-body approaches, including mindfulness, then we can really turn the tides of stress in our minds and our bodies.

Mindfulness is really the cultivated awareness of paying attention, on purpose, in the present moment, with non-judgment. So, it involves meditation practices that are really simple and effective, and it's a way to take care of your body, your mind, to reduce stress and really cultivate vitality. The strategy with mindfulness is really to recognize stress as it's happening and respond skillfully, rather than just reacting blindly.

There have been mindfulness studies on virtually every area, from neurological to cardiovascular to mental health conditions. Mindfulness has so many benefits that research has shown. With mindfulness, one of the main focuses that we will use is the breath, and isn't it wonderful that we're all always breathing? We are breathing 24 hours a day, whether we are trying to or not. This is a natural process that we can tap into at any moment to shift out of a sympathetic nervous system state into a parasympathetic nervous state, or the relaxational response.

So, if we can do even 2, 3, 5 minutes of mindful breathing in a day, we have the opportunity to actually change what's happening in our mind, change what's happening in our body, so that we can then actually gain greater perspective, which is one of the most powerful things that we can do with stress, is that ability to step back and see it from a big picture.

We can't always change what the stresses that we're facing are, but what we can do is change how we respond to them. The wonderful thing about these practices is that they're accessible and manageable for all of us. It really doesn't matter what your background is. It doesn't matter how old you are. It doesn't matter what culture you come from. It doesn't matter whether you're living with a disability or not; these practices are available to all of us, and can actually give benefit, regardless of what walk of life we're coming from.

I have to say that, as a clinician who is using mindfulness in our clinic and getting to see the benefit with my patients on a daily basis, is extremely rewarding. The comments that I get back from my patients who are using these practices, whether they're mindfulness practices or self-compassion practices, is that they feel like the pain does not control them any longer, that they are able to manage better, to actually be in control of their lives and be a friend to themselves, and that is a really powerful shift.

[relaxing, atmospheric music continues] So, why don't we try this together here right now? Why don't we take a few nourishing deep breaths with mindful awareness. So, if you'd like, you can close your eyes, turn inward, and we'll just notice together the inflow, the air moving in through your nose, down through your throat and into your lungs and out from your lungs, through your throat and out through your nose. So, just noticing a few breaths on your own, like this. [inhales and exhales deeply]

Lovely. So now, I'll just ask you to check in and notice, how do you feel? How do you feel when you just take a few quiet, slow, intentional breaths? Is there a shift for you? [relaxing, atmospheric music continues then fades out]

35:00 Heather
Dr. Bains, I'm really curious, how did you become interested in neuroscience, and specifically in studying stress?

35:06 Dr. Bains
So, my path to neuroscience is not a typical path. It's a very accidental path to neuroscience. I got into neuroscience because, to be honest, [chuckling lightly] I didn't really know what I wanted to do next with my life, [Heather chuckles] and so I looked into research in a lab, really like the lab, and so that was the start of my scientific career. I always tell people this, and they actually don't believe me, but that is the truth. I had zero interest in becoming a scientist [Heather laughs] at the age of 23. And then, it slowly just kind of happened and I just kept doing it and, as you immerse yourself in it, you just become fascinated, and I just wanted to dig deeper and deeper. I spent a lot of my time trying to understand synapses, the connections between cells and the brain, and how they work and how they lead to things like hyperexcitability, which underpins disorders like epilepsy, so I did some work on that. And then, when I set up my own lab in Calgary, I decided to start to apply some of the knowledge that I had around how synapses work to try to study stress. [gentle electronic music] It was an open field. I could see that this was really an important question to begin to dig into.

36:09 Heather
So, what brought you to Toronto and here to the Krembil Brain Institute?

36:14 Dr. Bains
It was a time in my career to just think about what I wanted to do next, whether I could have an opportunity that would test me in a little different way, and also provide a maybe a bigger platform to have greater impact. And I think, when I looked across Canada, there are not that many research

institutes like Krembil Brain Institute that afford you that opportunity and that possibility, and I think, to be in Toronto, which is a little bit of a return home for me, is amazing, but to also be part of the larger infrastructure and research collective that is here at University Health Network at the University of Toronto, at a number of affiliated hospitals, is really a fantastic opportunity, and there's really nothing like this in Canada. I truly think we have an opportunity to kind of harness the energy here and really make Toronto one of the neuroscience powers, globally. [gentle electronic music fades out]

37:08 Heather
I've heard you use the analogy that the idea of stress and the concept of stress is borrowed from engineering.

37:13 Dr. Bains
A Hungarian-Canadian scientist, who in English is Han Selye—all my Hungarian friends say it's Selye János is the correct way to say it—so, he coined this idea of stress in biology, borrowing from concepts in engineering in which materials are placed under stress to see when they bend or break. And so, he felt like this concept was interesting to apply to biological systems, and he said that any external or internal threat that challenges the survival of an organism will trigger a generalized, nonspecific response in the body to try to defend itself, and that's where this concept of stress was born. And, you know, he and others also, very quickly, realized that there is an optimal amount of stress that is actually very useful to the organism, so they said, "Well, too much stress is not a good thing, but not enough stress is also not a good thing," so this idea has emerged in the stress field that you want this kind of Goldilocks zone of stress in your life – these little challenges that you need to overcome, that you want these systems activated.

38:25 Heather
Okay. So then, are we any closer to understanding how to counteract the negative effects of stress and maybe bolster the positive effects of stress that make us more resilient? That would be exciting.

38:37 Dr. Bains
That would be exciting, I think it's really trying to figure out, not just about stress, but also about how the brain learns and remembers things. If you were to take this research and step back a few steps, in order to really understand the negative or positive impacts of stress on the brain and how they affect behaviours down the road, what you're really asking is, "How does the brain remember? How does the brain store information? How can we access that information?" and then, "How can we manipulate the information?" And so, we're getting a lot closer to having a better understanding of how that happens, but I think there is this emerging feeling that we need to also think more deeply about behaviour and different types of behavioural approaches and manipulations, incorporating a more kind of social behaviour approach to things is going to be important as we think about trying to find ways to mitigate stress.

[gentle electronic music] You know, as a neuroscientist, as somebody who thinks a lot about biology, for me, it's very reassuring that social interactions actually have effects that we can measure on the brain, right? So, I can then say, "Oh, here's the kind of, you know, molecular pathway that's affected. Here's the connection between these two cells that's affected," so it's not one of those things that seems like, "Oh, social interactions," and then some magic happens. No, no. We can actually say there is something physical that is happening in the brain that is changing.

40:01 Heather

And that is positive... most of the time.

40:03 Dr. Bains
Yes.

40:04 Heather
What about looking forward? I mean, we talked about being able to sort of measure levels of stress, biologically. Are there things coming up in the future in terms of research into biomarkers, for example? How close are we to something like that?

40:17 Dr. Bains
There are a number of different approaches to try to look at this. The classical approach has been to draw blood and look at levels of cortisol, for example. You can also get cortisol from saliva, you can get it through hair, and so that provides you a snapshot of an individual's stress level, but it doesn't really provide you information in real time about how an individual is managing a specific challenge in their life, right? Or whether their stress system is being activated, even in anticipation of something that may happen. And so, to get at that, there are a number of groups, including ours, that has been trying to think about different ways that we could have real-time evaluations of stress. So, some approaches using, you know, all these amazing devices that we wear – watches, monitors that provide immediate feedback are starting to think about creating algorithms that take heart rate variability, respiratory rate, how quickly you breathe, for example, combined with blood pressure in real time and creating some type of stress readout.

There are other approaches where people are trying to detect the molecules that are released during this response, so that would be like wearing a patch that collects fluid from sweat glands and then has sensors that are built in and then can talk to a device to tell you about your level of stress, so to create a kind of biofeedback. Those types of approaches are really exciting, exciting new avenues that we, and others, are pursuing.

41:53 Heather
That is very exciting. So, for example, somebody could be alerted to their stress before it escalates, and then be able to respond or mitigate the stress in some way?

42:02 Dr. Bains
That's absolutely right. Or I think perhaps, even more importantly, others may be alerted to your stress level, and I think about this a lot for things like children, for example, so parents may want to know, or even teachers may want to know. Some kids, when they're faced with a test or an evaluation, are great and have no issue with it. Others are enormously stressed by it. As an educator, wouldn't you want to know that? I think that would be amazing information to know, right? And to be able to think about how we teach children, for example, and to minimize stress in their lives.

So, I think there are just an endless series of possibilities. And then, we can also think about using devices like this in jobs that are laced with stress. We could think of primary care responders. We could think of healthcare workers, all of these folks to see, "Are there specific situations that trigger stress responses? After they've experienced something, the next time they go back to the same or similar scenario, do they show a really big stress response or not?" And we may begin to, you know, figure out who's resilient, what types of situations trigger specific responses. So, I mean, this is just me thinking out

loud and fantasizing about [chuckles lightly] what we could do over the next decade, but I don't think we're too far away from it.

43:14 Heather
[Your Complex Brain theme music] I have really enjoyed chatting with you today. I feel less stressed just learning about what causes stress and what's going on in my brain, [laughs] so thanks so much for taking the time.

43:24 Dr. Bains
Thanks Heather, my pleasure.

43:27 Heather
Thank you to Dr. Jaideep Bains, Dr. Katy Curtis, and to Farrah Schwartz for joining me on the podcast today. To access a five-minute mindful breathing practice that Dr. Curtis has created especially for us, please visit our website at uhn.ca/krembil and click on the show notes for today's episode.

This episode of Your Complex Brain was produced by Jessica Schmidt. Our Executive Producer is Carley McPherson. Thanks also to Dr. Amy Ma, Twayne Pereira, Suzanne Wice, and Meagan Anderi for their production assistance. If you enjoyed what you heard, please tell your family and friends, and leave us a rating and review on your favourite podcast listening app. Thanks for listening. We'll be back in two weeks with another exciting episode. Have a great day. [Your Complex Brain theme music fades out]