TRANSCRIPT

Key Conversations with Phi Beta Kappa

How Neuroscientist Susan Birren Is Mapping New Pathways from the Brain

The human brain has 100 billion cells, and there's still so much to discover about it. Brandeis University neuroscientist Susan Birren has dedicated her distinguished career to decoding the mysteries of how the brain functions and how it communicates with the rest of the body. In this episode, she talks to Phi Beta Kappa Secretary and CEO Fred Lawrence about the challenges and triumphs of such a singular pursuit.

Lawrence: This podcast episode was generously funded by an anonymous donor. If you would like to support the podcast in similar ways please contact Hadley White at hwhite@pbk.org. Thanks for listening.

Hello and welcome to Key Conversations with Phi Beta Kappa. I'm Fred Lawrence, Secretary and CEO of the Phi Beta Kappa Society. This podcast features conversations with Phi Beta Kappa Visiting Scholars who spend one academic year with us. They travel to up to eight Phi Beta Kappa-affiliated colleges and universities, partake in the academic life, and present a lecture on a topic in their field. Lectures are always free and open to the public. For a full schedule, and to learn more about the program, please visit pbk.org.

Joining me today is Susan Birren, a professor of biology and neuroscience at Brandeis University, who's also served as the Dean of Arts and Sciences at Brandeis. It's a particular pleasure to have Susan with us today, as she was a member of my administrative team when I was President of Brandeis University.

Professor Birren's lab work maps how signals to the heart are generated in the brain and interpreted and modulated by a second nervous system located outside of the brain and spinal cord. Her other research interests include how the developing brain relies on a coordinated series of chemical and electrical signals as well as cell contacts to establish the neural circuits that control brain function. Welcome Professor.

Birren: Thank you so much for having me, Fred.

Lawrence: You know, when people want to say that something is not that complicated, the two things they usually will say are ‘it's not rocket science’ or ‘it's not brain surgery or brain science.’ Now you're not a rocket scientist, but you are in fact a brain scientist. You're a scholar in developmental neurobiology at Brandeis for 25 years. Do I have that right?

Birren: I just got my Louis Brandeis bust.

Lawrence: Which means you're a quarter century into your career at the University, and as a Dean of Arts and Sciences you've dealt with a broad range of the challenges that liberal arts education has. I want to get to all those things, but let's start first with a little bit more of your journey.

So although you've had a distinguished career in New England at Brandeis University, your actual education and before that your childhood began in your time in California. Is that right?

Birren: So I grew up mostly in California, in northern California. I went to Berkeley as an undergraduate and then to UCLA, where I got my Ph.D., and then moved over to CalTech to do postgraduate research at CalTech.

Lawrence: Was there a time along the way, maybe even a moment, when you said ‘I want to be a scientist’?

Birren: So I was I think a late bloomer, because many people know that they want to be a scientist from the time they were a child. It was something that I learned when I was in college and started taking classes mostly about biology and biochemistry, and it just seemed as though it was interesting. It explained things that I was interested in. It let me understand how the world and how we work, and so it was something that I became progressively more and more and more interested in.

Lawrence: What did you think you were going to be interested in when you went off to college? And college was at Berkeley, right?

Birren: College was at Berkeley. So I didn't know I was interested in math when I was in high school, but I didn't really know anything about it. And so when I went to college I started taking math classes and ultimately--and this is a journey I would say that I've taken over the years--I became more and more interested in people and how the science relates to people and how... Eventually, how the science that we do affects people, and can we learn things better, interesting in terms of the way the brain works, the way the body works, the way these things interact.

And ultimately, this is where my journey has led me to ask the question, do these answer questions that we have about human health and can we make contributions to understanding how the body works?

Lawrence: I know both of your children are now grown and out of college, but during the time we worked together when you were a dean, and certainly before that as a full-time neurobiologist, you were raising a family at the same time as having a very prominent and successful scientific career.

Birren: And that was a good thing. I like to think that it's good to have multiple different parts of your life, because when something crashes at work, and your grant doesn't get funded, and you're having trouble with your students, you know, you can go home and have a fabulous time with your children or with your spouse. And when things are... You really don't want to see your children right then, at least you have the lab to go to.

Lawrence: You can always go back to the lab.

Birren: Right.

Lawrence: I remember a lecture that you gave and you quite memorably said to the students, "The things you're going to be studying here at Brandeis, many of them haven't been discovered yet." And it was electric. You could feel that through the room. So is that idea of discovery as part of the part of education a way in which you've drawn together both your research and your teaching?

Birren: Certainly at Brandeis we really engage undergraduates in research. So we teach in the classroom, but we spend a lot of time teaching outside of the classroom as well. And if you look at the research that I've done at Brandeis, and you look at for instance my publications, many of them have undergraduates as co-authors on peer-reviewed publications.

So one of the things that I certainly believe is that, because it was true for me as an undergraduate, is sometimes you don't know. No high school student knows that they want to become a neuroscientist. Certainly I didn't know that I wanted to become a neuroscientist.

And so, unless you have the opportunity to get out there and actually do it, you have no idea how much fun it can be, because it can sound dry, and certainly being a scientist is nothing but frustration. Most of the time the experiments don't work. But that moment when something does work or you have an idea and it makes perfect sense. It could turn out to be wrong, but it's electric. And so that's what you're trying to communicate, is that there are ideas, and those ideas didn't

exist before you had them, and you can actually do something as a scientist to test those ideas and take the next step.

Lawrence: And even as an undergraduate you can have that experience of trial and error and discovery and really epiphany moments.

Birren: I think that's where it's got to start. So many of the places that I visited as a Phi Beta Kappa Scholar this year, they have these amazing programs where the students are working, and these are oftentimes at small liberal arts colleges, where the students are carrying out independent research projects with their faculty members. And you can see the spark of what they are able to do that is outside of the classroom, which is really exciting and it's a nice thing to see.

Lawrence: So let's talk a little bit about some of the important science research you've been involved in. We usually talk metaphorically about thinking with our brains versus thinking with our hearts, but you in a non-metaphorical sense have very much worked on the heart-brain connection, the way the brain sends signals to the heart, and what you've described as the second nervous system. Tell us a little bit about that work.

Birren: I love this work. It's certainly work that's developed over the last few years, but it's something I've been interested in a long time. So, your heart beats, and it's going to beat no matter what. It really doesn't need your brain at all.

Lawrence: I don't do anything to make that happen. That's like the background on the program on the computer, it runs on its own.

Birren: Right. But if we would open the door and a tiger wandered in, what would happen to that heartbeat?

Lawrence: I'm guessing that my heart would beat lot faster if a tiger wandered in.

Birren: It would. And when your spouse, the first time you ever saw her when she walked into the room, might your heart have beat a little faster?

Lawrence: Not just the first time, Susan, every single day.

Birren: So clearly, somehow, you are getting signals from your environment telling you to speed up your heart rate. How do you think that happens?

Lawrence: And I have no conscious means of controlling that. It's just happening.

Birren: It's just you have no control over it.

Lawrence: Right.

Birren: But it all goes through your brain, and it goes through your brain through your senses. So you see something, you hear something, maybe it was her perfume. But something triggered a response in your brain and your heart beats faster. And so that's what I study. To study this is to ask, what are the components? What are the pieces of it? And if you do that and you study how the brain communicates with the heart, what you find out is that there is a constriction point. There's a point through which all communication passes. And if you have a constriction point, it gives you a control point because all of the information from the brain, from all of the sensory information that's coming in, is flowing out to the brain through a tiny number of cells. This small group of cells that all the information is going out through, there might be a few thousand of them. So it's tiny and so it gives you actually a way to approach the problem.

And if you think about something like high blood pressure, hypertension, if there is a very small number of cells that is... And so I should just mention that hypertension is a situation where the heart is, there's too much pressure in the arteries, and often that is partially because the heart is responding and beating more strongly.

Lawrence: Working harder than it should.

Birren: Working harder than it should. And then that feeds back and creates problems because there's a lot of flow through the arteries, and you can have strokes, or you can have myocardial infarctions, and so all of this stuff is downstream. This is why we work so hard to control blood pressure in the population because it is by far the biggest risk factor for heart disease and heart disease is the number one killer of people in the US. So it really makes sense to me, and it's all connected to the nervous system. So it turns out that the biggest risk factor for hypertension is too much information coming from the nervous system and so it's driving the heart too hard, it's causing constriction of the blood vessels, and so we really want to understand what's causing this communication.

So we've really focused down on this very small number of cells and trying to understand what the signals are, that are telling these cells to drive the heart and the vasculature harder, and how you might relieve this.

Lawrence: So I think of your work as pure science, research, and yet a lot of what you're talking about sounds very closely applied to issues we think about all the time. Hypertension, myocardial infarction, the kinds of clinical concerns that one would talk to one's internist about.

Birren: That's exactly right. And I've become a lot more interested in some of these

questions of how these things relate to human disease. And so it turns out... You've probably heard of a beta blocker.

Lawrence: Sure have.

Birren: And so beta blockers are one of the most commonly prescribed drugs in the Country and they're used to treat hypertension, they're used to treat various kinds of heart disease. It turns out that beta blockers only have one function, and that's to target the small population of cells, which are called sympathetic neurons, by the way, and so to stop the communication from the nervous system to the heart. So that's really great, except that it doesn't work in about 50% of the people who take these drugs.

Lawrence: How do we know or what do we know about for whom it works and for whom it doesn't work?

Birren: Well, it turns out to be complicated, because there are lots of different things that feed into hypertension. There is this sort of increased, what I refer to as sympathetic drive, but there are also hormones that are circulating that will cause constriction of blood vessels, and there are a number of different things. It turns out that this sympathetic nervous system is, sort of, again, the central point that controls all of these things. And so these beta-blockers block those, but it turns out that there are lots... So a beta blocker, by the way, is a drug that blocks beta-adrenergic receptors, which are the receptors that recognize the signals from the nervous system.

Lawrence: How does it block them?

Birren: If you think about the nervous system, people understand that the nervous system is made up of neurons which are just nerve cells, and that they communicate with other cells by releasing a chemical. And that chemical is called a neurotransmitter. And this particular type of neuron releases a neurotransmitter which is called norepinephrine, also known as noradrenaline. And that release causes the heart to beat faster, and it causes it to beat faster because it's released from the neuron. It binds to beta-adrenergic receptors, and beta blockers look a lot like noradrenaline. And so they bind to the receptors first before the neurotransmitters can get there.

Lawrence: And they cut it off at the pass, and they keep that information from being communicated the way you're talking about them being communicated.

Birren: That's right. So the heart rate doesn't go up.

Lawrence: So when we talk about our heart automatically beating faster, that's what's going

on in the background that's making all that happen?

Birren: Right. Beating faster, increased cardiac output, and a number of other things.

Lawrence: So are beta blockers a good thing? Are they being overly prescribed?

Birren: No, they are a good thing. The problem is that these receptors are expressed in a wide variety of tissues, so sometimes they can have effects on the kidney or effects on the gastrointestinal tract, which you don't necessarily want. So one of the questions in beta blocker therapy is how do you make them as specific as possible. And the other problem, which is probably a bigger problem, is that there's huge individual variability in people's responses to beta blockers, and so this goes into this idea of personalized medicine, and how do you prescribe the drug that's actually going to work for that person.

Lawrence: When I think about specialties in medicine, I do tend to think of them in terms of Body parts or systems. I think of neuroscientists on the one hand, or neurosurgeons on the one hand, cardiologists on the other, but it sounds like from the point of view of neurobiology, you're actually dealing with the heart quite a bit.

Birren: I'm sort of an odd neuroscientist, because it turns out that these neurons that we're talking about aren't actually in the brain. So the brain sends out signals to the spinal cord. The spinal cord sends out signals to a set of neurons that sit just outside the spinal cord. So these few thousands of neurons that we've been talking about aren't part of the brain. They're not part of the spinal cord. They are that peripheral connection and they sit outside. Part of the reason I started doing this is because I'm a big fan of making things as simple as possible, and the brain just seems ridiculously complicated. And so when I first started working on this, I thought, "Well, that's interesting. It's a small number of neurons, you can get it out of a mammal, sort of a rat, and you can actually study them in isolation." And it turns out that there's a large history in neuroscience of studying small circuits to understand the mechanisms by which big circuits work. And these can be in a fly, in a fruit fly, it can be at Brandeis University in a lobster or a crab, or it can be in these peripheral neurons.

And so, what you're doing is you're taking a simple case, you're studying how a circuit functions, and it turns out they’re exactly the same mechanisms that are used in bigger, more complicated circuits and so you can get a lot of information about what the signals are, what the proteins are, what the receptors are, and how these things all communicate with each other.

Lawrence: So when you're studying this in your lab, how conscious are you of the idea that

this could lead to treatments for heart disease, and how much is it that you're going to set that up for somebody else to do? How direct you see the connection between your peer science work and the applied work that could come out of it?

Birren: I think that's a great question. I think that over the years, a number of us have become much more interested in what the implications of our work are. I talk to people at medical schools. I'm not designing drugs, and I don't really have, as a scientist in a university lab, I don't really have what I would need to do a really large scale drug experiment. So I'm just going to be talking to people and trying to convince them that this is a pathway that potentially we could look at. So we're really interested in these neurons. We know that they're important. Beta blockers are a major drug. We know that beta blockers don't work in all people, and are they not working because, it's not that those nerve cells aren't a great target, but maybe the beta blocker isn't the right point for us to be looking. Can we be looking at a different point that is also going to be able to control and then you can begin to layer different therapies? Those are the kinds of conversations that I want to be having with people.

Lawrence: I remember one of our early conversations when you became a dean was about how long you were going to be in that position and what the trajectory was from there. One trajectory is to continue in academic administration, another which is the one you've chosen, is to go back to the lab. Tell us a little bit about what that decision was like.

Birren: So that's a hard decision. I should say that I maintained my laboratory the entire time that I was dean. But over time, the lab got smaller and smaller and smaller. And after five years, it became clear that I was going to have to make a decision, that it was very hard to keep the energy going in the laboratory to be making progress, especially because the technology moves so fast, and that I really needed to pay more attention, and being dean is sort of all-consuming and so you really don't have the focus to sit down, and for instance, write a grant. And so that was a really hard decision.

Lawrence: I know one of the ways in which you were very involved in trying to improve the trajectory of the institution was the initiatives to broaden the diversity and inclusion efforts, both with respect to students and faculty. Want to tell us a little bit about some of those efforts?

Birren: I would say in terms of students, I was mostly focused on creating opportunities in sciences. As dean, I was fairly focused on trying to diversify faculty and that was a huge and ongoing learning experience. I'll just tell you a couple of my take home...

Lawrence: Please.

Birren: ...take home lessons from that. And one is that it really doesn't do you any good at all to spend a huge amount of effort in hiring diverse candidates for the school, if the school does not have an environment and a culture in which they feel like they belong, and this is their place. So I spent a lot of time thinking about faculty recruiting. But then ultimately, I spent more time thinking about the campus environment. And so when I talked about helping to start this African Diaspora cluster, it was a hiring initiative, but it was more than hiring initiative. It was an initiative to make this part of everybody's university. What that meant was that it wasn't about the Department of African and Afro-American Studies, it was about all of the departments, and how they work together, and how we could create programs that students and faculty would be interested in. And these are real concerns on campuses, and certainly it's a concern at Brandeis, which is, how do we make this everybody's campus? How do we make this a truly place of belonging for all of our faculty members?

Lawrence: So what's on the nightstand or what's on the iPad? What are you reading now?

Birren: Well, interestingly, I got off the airplane and I actually sat in the airport because I wanted to finish the book that I was reading before coming on here.

Lawrence: Perfect. What's the book you had to read in the airport?

Birren: It's a book called *Educated*, and it's by Tara Westover, I think her name was. It's about a woman who grew up in a survivalist family and a brutal upbringing, who then went on to get a Ph.D. in history, and it's her telling her story. And so when I'm thinking about this move from thinking globally, it very much resonates with this story from thinking about tribalism to thinking globally.

Lawrence: And back all the way to the individual and back to the lab working with individuals and on your own research.

Birren: Yeah.

Lawrence: Susan, thanks for being with us today. Pleasure to be back together.

Birren: Yeah, it's great to see you again, Fred.

Lawrence: This episode was produced by Lantigua Williams & Co. The episode was mixed by Paulo Mardo. Our theme song is “Back to Back” by Yan Perchuk. To learn more about the Phi Beta Kappa Visiting Scholar Program, please visit pbk.org. Thanks for listening. I'm Fred Lawrence. Until next time.

CITATION:
Lawrence, Fred, host. “How Neuroscientist Susan Birren Is Mapping New Pathways from the Brain.” *Key Conversations with Phi Beta Kappa*, The Phi Beta Kappa Society, August 30, 2019. www.pbk.org

Produced by