

Nervous System 101

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Dr. Benjamin Greenberg: [00:00:05] Hello everyone. My name is Dr. Benjamin Greenberg and I'm a neurologist at the University of Texas Southwestern Medical Center in Dallas, Texas and I'm pleased to be with you today to offer a high level introduction to the nervous system, to kind of set the stage for all the other lectures you're gonna listen to and discussions you're gonna have because in the world we live in and the disorders as clinicians that we work to diagnose and treat affect the nervous system. It's important for everyone, patients, and families to understand what's involved and why do we get certain symptoms and not others?

[00:00:37] And over the years, I've tried a variety of different ways of explaining the nervous system. Something that we have studied, personally professionally for over a couple of decades, how do we break it down into bite-size pieces so that we can all be speaking the same language? And some of you may have heard me use this analogy before, but the one that I find most appropriate for understanding the nervous system is actually compared to a stereo system.

[00:01:01] Now, for some of the younger folks in the crowd, that top left picture is of a record player or turntable. I hear they're making a comeback, which is very exciting, for those of us who lived through the eighties and nineties, there are receivers down at the bottom left where we would receive information through radio signal or maybe pop one of those ancient devices, a CD in the CD player and those systems would input information into an amplifier, which is on the right and then the amplifier could send out through wires the information to speakers all throughout your house. And you could set up zones of speakers so you could listen to music in your bedroom or on the patio or in the kitchen.

[00:01:47] And in this stereo system we understand that a signal has to be generated, has to be transmitted. And then after that transmission you get ultimately that music that you enjoy. Now, in the middle that amplifier is there to do a lot of processing, it's there to understand what are signals being received and then to distribute it out to the right zone. So, there is essentially a computer in the middle of this. A decision maker to help navigate the inputs and the outputs that make up this entire stereo system. Now this is the big picture.

[00:02:26] If you will, the macroscopic view of a stereo system, what we would see just sitting in our living room, looking at the shelves that have all these different components. But if you look closer within each of

these there are microscopic aspects, small aspects that make a speaker, a speaker an amplifier, an amplifier, a record table, a record table and yes, make a speaker wire a speaker wire.

[00:02:50] And if you look closer at the speaker wire, you find that that wire connecting the different parts of the stereo system have a copper wire on the inside and around it there is insulation. And that insulation is there to do several things. It's there to protect the wire from damage as well as speed up the signal getting from point A to point B. If you damage that speaker wire and you look at the stereo system, the signal can't make it from the amplifier to the speaker and then you don't hear the music as well or it sounds scratchy or noisy, but in the end it's just not as robust as it used to be.

[00:03:27] So that installation, that microscopic view of the actual speaker wire is important to understand. So, we have to have a working knowledge of the big picture and the small picture in order to understand how a stereo system works and essentially the nervous system can be broken up in the exact same way. So, if we think about the big picture of a nervous system there are inputs and outputs. So, on the left-hand side we talk about different sensory inputs that the human being may experience.

[00:03:58] So instead of an input from a record player or from a receiver or CD player, you receive input from your eye, you have vision, the sensation of vision. You receive input from skin sensation. The touch and the feel and the temperature and the vibrations that you feel is one of the inputs that goes up into the nervous system. We hear things and so hearing is a sensory input. So, there are lots of sensory inputs. I just gave a few examples.

[00:04:26] That information moves into that supercomputer that makes sense of it all, which is the brain. And then the brain can make decisions based on those inputs and based on internal thoughts that we have, and it can elicit an output, it can send a signal out to our speakers or in this case the muscles on the other side of the screen to get an output. In this case it would be movement, which is the number one output of all human beings.

[00:04:53] In fact everything we do that is a generated signal other than thought involves movement. This is including speaking, which is the coordination of a lot of different muscles. And so those movements are like the speakers, if you will, the music being produced by the speakers and the inputs are coming from a variety of different sources. So, if you think about the nervous system as one big stereo system in the big picture, you could break it down into its different components.

[00:05:25] So instead of talking about receivers and amplifiers, in terms of the nervous system in the big picture, we talk about the central nervous system and the peripheral nervous system. And what's the difference between the two? So, the central nervous system includes the brain and the spinal cord. The peripheral nervous system are all of the nerves that are either going into or out of the central nervous system.

[00:05:49] So if we were thinking about a stereo, it would be the amplifier that was the central nervous system and the wires coming in from the record player and going out to the speakers and the record player itself and the speakers themselves would all be part of that peripheral nervous system. So, we break things down at the macroscopic level, just like we do in a stereo system.

[00:06:13] And we talk about the central versus the peripheral nervous system. But we also break things down at the microscopic level. So just like that speaker wire has a copper wire that's insulated. The same thing happens to the wiring within the nervous system. And this is true for the peripheral and the central nervous

system. There's a starting point of your wire. We and in this case, we talk about the cell being a neuron. The starting point is the cell body.

[00:06:44] The wire that copper wire that is projecting out to some target, whether it's a speaker to listen to music or my right thumb muscle to get my thumb to move that wire projection is called an axon. And then the insulation around it. Instead of using red and black rubber or plastic or foam, the human body uses a substance called myelin or the myelin sheath. And the myelin is there to do the exact same thing to your axon that that red and blue -- excuse me, red and black insulation is meant to do to the copper wire.

[00:07:14] It's there to protect the wire and it's there to speed up the signal getting from point A to point B. So that if you were to damage the insulation on the speaker wire and you wouldn't hear the music as well or not at all, the same thing is true for the nervous system. If you damage the myelin, the signal doesn't get through as well. So, if it happens to be the axon that is going to your right thumb and you damage the myelin around it, your thumb won't move as well, because the signal doesn't get through. Nothing wrong with the stereo, nothing wrong with the speaker, but the connection gets damaged.

[00:07:50] Now that connection can be in the central nervous system or the peripheral nervous system and it's up to us neurologists to help everyone sort out which is under attack. And this is what brings together this anatomy, this big picture in microscopic picture into exactly what neurologists do. So, in neurology we localize first, what does that mean? Our first job when somebody comes to us with a concern whether it's weakness or numbness or vision issues, you name it is to localize whether or not the problem is within the peripheral nervous system or the central nervous system.

[00:08:32] Because there are very different diseases that affect the central nervous system or the peripheral nervous system. We have strokes, within the central nervous system, not the peripheral nervous system. We have certain diseases like myasthenia gravis or Guillain-Barré syndrome that affect the peripheral nervous system but do nothing to the central nervous system. And then we have conditions like transverse myelitis, acute disseminated encephalomyelitis, autoimmune encephalitis that affects the central nervous system, but not the peripheral.

[00:09:02] So as you can imagine if somebody comes in with weakness of a right thumb, the problem could be either central or peripheral and it's up to health care providers and in particular neurologists to help everyone understand which has been damaged. The central or the peripheral or both. But once we localize at the macroscopic level, we then have to get to the microscopic.

[00:09:25] So to say that somebody has a central nervous system condition isn't doing our job completely. We then have to figure out was the cell body or the axon or the myelin damaged? Was it the very beginning of the wire within that amplifier, the wire itself or the insulation around it? Because there are different diseases that affect each of those different components.

[00:09:49] Knowing that a wire is rusted is important, because then you know the insulation is intact and you can work about managing your stereo system differently. So, the first thing we do is localize is it central or peripheral? Is that the wire or the insulation or both? And then we diagnose then we have to decide now that we know what is damaged, how did it get damaged? And this is where neuro immunology comes in and you're gonna be learning about immunology separately.

[00:10:21] But that is the 'how' of damage. And what we just talked about is the 'what' was damaged. So, as you think about the nervous system and you think about these different conditions, I want you to remember

to ask yourself for each of the conditions you learn about was the damage to the central nervous system or the peripheral nervous system? Was the damage to the wire or the insulation or both? And then go on to ask how did that damage occur?

[00:10:46] How can we get better from the damage? How can we recover from the damage? And importantly, how can we prevent that damage from ever happening again? I hope you found this helpful. And looking forward to all of the other talks and lectures and thank you for joining us.
Thank you very much, all.