>> March 15th, 2017. Lecture 12. Actually our second lecture in this unit, which encompasses the nervous system. And there is no more important component of that system than your brain. Your brain weighs about three pounds right now. It was only about a quarter of that size when you were born. And it actually stopped growing at about the age of six. And you say, whoa, I'm smarter now than then. But actually the physical size of your brain stopped growing at age six. What makes you smarter is not a bigger brain, but more synapses. And how do you develop more synapses? You use your brain. Are you using it right now? Are you learning something novel, something different, something new? So whether it's a foreign language or whether it's studying anatomy, you develop your brain by, obviously, using the brain. It's that old adage: Use it or lose it. It's interesting because the brain is the only organ that has the capacity to study itself. Indeed it's the only organ that can study anything. And when you cut right down to it you are your brain. I mean, are you your pancreas? You hear people say, well, what does your heart tell you? What does your gut say? Well your gut doesn't tell you anything. Your heart doesn't know anything. Those are just stupid organs. All of those are designed to support your brain. You are your brain, and without your brain you are absolutely nothing. Right? All right. So we have the highest regard, naturally, for our brain. That's particularly paradoxical, because in antiquity early anatomists actually dismissed the brain as being totally unimportant. They thought it was too cool the blood. A complete nonsense with our modern understanding, but, yet, understandable. Because to look at the brain, there's nothing about it, nothing that's visually telling about it. By looking at a brain do you have any idea what it's actually doing? No. So naturally, at first, it was quite a mysterious organ and still remains so today. So let's layout our agenda. In fact we're going to spend two sessions with the brain. And an entire lab devoted to the brain, as we should. So let's map it out. Let's layout our attack for this brain. Essentially the brain can be arbitrarily divided into three regions. And this is arbitrary, meaning artificial. But a good way to, at least, approach a complicated organ like this. So with that said, the brain has three parts: front part, middle part, back part. Front part is called forebrain, more eloquently it's called the prosencephalon, because it is the most pronounced. And this is divisible into these parts: the cerebellum, the thalamus, and below that the hypothalamus. We'll be lucky to get down to the thalamus today, because it's so complex to get even that far. Then after the forebrain, we'll look at the, so-called, midbrain. Also known as mesencephalon meaning middle. And the midbrain is divisible into these parts, which we'll give meaning to later: the cerebral peduncles and the corpora quadrigemina. Right now those are perhaps meaningless words, but they are subparts of the midbrain. Forebrain, midbrain, and hindbrain. Hindbrain, aka, also known as, rhombencephalon. A reference to a rhombus, which is kind of a diamond or a pyramid. Anyway, the hindbrain consists of the cerebellum – a word which means little brain – and the pons, and poking out of the foramen magnum the medulla, also known as the medulla oblongata. So this is our agenda. And, again, today we're going to begin with the forebrain, probably knock off the cerebrum, and we'll be lucky to get much

further than that. So it's a complicated but yet unified structure. Don't get me wrong. We have but one brain, but these are the anatomical sections, which have recognizable functions which we'll try to unravel. Certainly here's a typical view. Everybody would recognize this as the human brain. And most of what we're looking at is the cerebrum, which is, of course, the dominant structure of the forebrain. So let's look at it. The cerebrum is actually two identical mirror-image structures. And so with that said, you could argue that you have two brains, at least you have two cerebral hemispheres. What's the word mean, hemisphere? Half a sphere. If we look at the brain from the front, we see that we have a left cerebrum and a right cerebrum, and these are identical anatomically. That is to the gross observer that is to look at it with the naked eye they appear to be identical. In fact, you could drop a knife down through the center and not make contact with anything, because there is a very deep fissure, which is found between these hemispheres. And the name of that fissure is the longitudinal fissure, because it is a longitudinal fissure. Sooner or later as that knife drops down you'll encounter something hard. And that something can be seen internally, in this case marked as a blue structure, the so-called corpus callosum. Corpus doesn't have to be a strange word, you've heard it. You've heard of a corpse, right. What's a corpse? A body. And so the word corpus is Latin for body. And callosum is Latin for hard. So literally corpus callosum means hard body, which is a description of its composition, but doesn't really lend much information about its function. We're going to learn in a moment that basically it's made up of neurons that are going left and right, right and left. So it's a bridge. You could say it's a connection, which allows communication really between the left hemisphere and the right hemisphere of the cerebrum. Tends to be larger in women; nobody knows why. Just a little factoid. But the corpus callosum then is what connects the left cerebral hemisphere with the right cerebral hemisphere. And, therefore, allows them to communicate as a single structure. So as we look to the surface of the brain, we're sort of hard-pressed to map it out, because it looks rather non-descript. This is an actual photograph of the cerebrum. A lateral view. And you have one here as well. We're certainly struck by the fact that the brain is very convoluted. It's folded, it's pleated, you could say. And we might have mentioned before that this is a mechanism to allow you to fit more things in a small space. Indeed if you want to cram something into a small space you have to fold it in order to get it into a small space, and these folds, these bulges and creases are called gyri and sulci. We'll talk about those in just a minute, but if we're going to map out the cerebrum – and indeed we must. It's tempting and convenient to give names according to the skull or cranial bones which lie above these regions. And so the natural name for this part of the cerebrum would be the frontal lobe, back here the occipital lobe. This would be the temporal lobe and parietal lobe. So that's almost an obvious, easy choice when it comes to naming these parts of the cerebrum. But it's not quite that clear cut, because where does the frontal lobe stop, where does the parietal lobe begin, what landmarks can we use to delineate these parts. The cerebral lobes then are actually demarked by what are call sul-see [pronounced phonetically] or sulci, which is plural for sulcus. And these have no function other than to distinguish these lobes, which we're about to give names to. First, then, the so called lateral sulcus. You could label it here, and you will in a minute, but apparently the lateral sulcus divides what? Separates the temporal lobe from the parietal lobe. So in the sketch that you have, this is what lobe? Temporal lobe. This is what lobe? Parietal lobe. In case you can't see that. What's this lobe here? Temporal lobe. Up here? So what's this groove? [inaudible] It's called the lateral sulcus. Again, the lateral sulcus has no function. It's just a landmark, but it serves to divide and separate and delineate the temporal lobe from the parietal. Then here, in the sketch that you have, there's another sulcus. And it basically separates the parietal from the frontal. And its name is? Central sulcus. So if you haven't already done so label this as the central sulcus. This is the lateral sulcus. The third and final sulcus can't really be seen on the surface, the outer surface. But if you section the brain, if you cut it sagittally you can see this sulcus right here, which serves to divide the occipital lobe from the parietal. And naturally it's called the parietal-occipital sulcus. We say it's indistinct, that means hard to see, on the outer surface. So before going on, let's be clear. This sulcus here? That separates the temporal from the parietal that would be the lateral. This one running through here is the central. And if we look through a sagittal section we see this sulcus, which is quite pronounced, apparently dividing the occipital lobe from the parietal, so that would be– –the parietal-occipital sulcus. So these are landmarks, convenient markings really, which allow us to make these distinctions. On this view, which you have as well, the lateral sulcus is labeled for you. The central sulcus is labeled for you, but notice the parietal-occipital is not shown, because you can't see that unless, unless you make a midsagittal section as seen here. So indeed this is the cerebrum. Cut how? A mid– sagittal. And what's number four, as long as we're reviewing or making clear. That's the corpus callosum. Great. Now as we look to the cerebrum, especially in a frontal section, we would see that yes it is wrinkled. And those wrinkles are called sulci and gyri. Gyri plural for gyrus. Gyrus is a bulge; sulcus is a groove. Gyrus is a what? Bulge. Sulcus is a–? Groove. And so certainly there are numerous gyri and sulci over the surface of the brain. This is the undersurface of the brain, where we reveal the temporal lobe, the frontal lobe, and we can see a glimpse here, also, of the longitudinal fissure. This is a cutaway view. And a close-up of the gyri and the sulci, which are so typical. But the most revealing of the sections is one like this, which is a frontal section. You can see the longitudinal fissure, you can see nicely the gyri and sulci, and, certainly in the lab and even in this drawing, you can see that the surface is darker material than the interior. And that darker material is called grey matter, also known as the cerebral cortex. The word cortex means bark. And it penetrates about half an inch, at most, from the surface. So the cerebral cortex is made of grey matter, and it's folded and pleated into these gyri and sulci that we mentioned. But to say that it's grey matter is just to describe a color, why is it grey. Or better, why is it not white. It's not myelinated. And the reason it is not myelinated is that here we nerve cell bodies. That means soma, which are not myelinated. So the cortex is dominated by nerve cell bodies, and as a result is not myelinated, and as a result it's grey. So you can call this area grey matter, you can call it the cerebral cortex, and it is highly convoluted, as we've said. Deep to the grey matter, you're struck by a transition in color. It's largely white or at least whitish. And what makes brain material white? Myelin. So this must be an area of heavy axons that is nerve fibers which are myelinated. And if you recall what are the cells that provide myelin in the brain and central nervous system in general? Oligo– -dendrocytes. Oligodendrocytes. Now the white matter is basically, again, axons, which are criss-crossing the interior of the brain. Some are going left to right, some are going front to back, some are going up and down to put it very simply. And these highways are called tracts. How do you spell that? T-R-A-C-T-S. These are called white matter tracts. And there are three based upon the orientation of these axons. The first one association tracts. They basically connect gyri on the same side or within the same hemisphere. So let's talk about this sketch. This is a frontal section, right. What hemisphere is this over here? Left. And so if we point to a spot on the left cerebral cortex, and if it's connected to another spot on the same side, what would you call a white matter tract which communicates or links that spot with that spot? You'd call it an association tract. So to repeat, an association tract is a white matter tract which is communicating or allowing connection between spots or gyri on the same side. Then there are commissural tracts. The word commissural means to connect. And these are those that, in fact, do that. If we– If we spotlight a location here and that same location on the opposite side, are they connected. Yes. And what is the connection that, basically, allows communication between this spot and that spot? A commissural tract. So a commissural tract allows connectivity between gyri not on the same hemisphere, but what? Opposite hemispheres. And now you can answer the question what is the corpus callosum made of? We described it as a hard body, but that's really meaningless. The corpus callosum is right here. And what is the corpus callosum made of? Yes, it's white; yes, it's hard, but it's made of commissural tracts. It is the largest commissural tract in the brain, essentially allowing the left hemisphere to communicate and coordinate with the opposite side. Finally in the category of white matter tracts are projection tracts, and that word is somewhat intuitive. To project is to throw something out there. And so a projection tract is one which is, what? Carrying information to or from areas outside of the cerebrum. That is from other areas of the brain, and, therefore, is essentially moving up or down. That is carrying signals up and down. So to repeat. White matter which bridges gyri on the same side? Association. Gyri which allow communication between left and right hemispheres? Commissural. Gyri– Tracts which allow for communication outside the cerebrum or into the cerebrum from other areas? Those are called? Projection tracts. All of these are white, for what reason? Myelinated. And myelin here is provided by oligodendrocytes. Now the fun part. Now that we've mapped or at least given names to these areas, we want to assign functions to these areas. At least to the best of our knowledge. And that's an interesting, sort of, question to, at least, contemplate. We're about to give you functions for these lobes and parts of these lobes. But how do you supposed these functions were ever deciphered?

I mean, by looking at these lobes can you tell what they do? Well, so it is quite amazing that our knowledge that we're about to provide actually came as a result of injury. There's that old saying you don't know what you have until– what? It's gone. And what's the most common injury to the brain other than outright trauma? The most common injury to the brain is a CVA, a cerebral vascular accident – commonly called a what? Stroke. When people suffer from a stroke do they have obvious, clear cut deficits? Have things changed? And then later, let's say, upon their death can their brain be autopsied. And can we discover areas which are destroyed. And so can we correlate their symptoms after the stroke with these areas, and therefore can we assign function based upon what they lost as a result of their stroke. So that has always been the way to decipher. That is to examine brains in an autopsy and therefore deduce the functions of these areas. So let's do it. The frontal lobe, it's a pretty big territory. In fact to be exact the frontal lobe is everything in front of the central sulcus. Quite a bit of real estate. And the area immediately in front of the central sulcus is shaded here in blue, do you see that. That area in blue is called the pre-central what? Gyrus. The pre-central gyrus. Why is it called that, because it's immediately in front of the–? Central sulcus. And so the pre-central gyrus we know is basically the primary motor strip, as it's called, or primary motor area. This is the area which initiates– initiates voluntary movement. So if you decide to move your pen across the paper that idea, that decision came from the–? Pre-central gyrus. If you decided to move your left hand that decision came from the right– the right pre-central gyrus, perhaps you already know that the left side of your body is controlled by the right side of your brain and vice versa. So this is important, and certainly a question that would be fair and reasonable. Let's say a patient suffered a stroke, which damaged the left pre-central gyrus. Damaged only the left pre-central gyrus. What would their symptoms be? Problems moving what? The opposite side, the right side of their body. And it's just that simple. In fact, very discrete lesions would cause very discrete paralysis. That is you might have no problem moving your right leg, but you might have difficulty moving your right arm. But in general this area is concerned with voluntary movements on the opposite side. The pre-central gyrus. Everything else in front of that or, excuse me, at the base of the pre-central gyrus is an interesting and somewhat discrete area found only on the left hemisphere, for the most part in most people, and it was first described by a physician. His name was Broca. And it was given his name, because he had a patient – perfectly normal patient – who one day suffered a stroke and couldn't speak from that day on. Later, much later, as that individual died they discovered that this area was damaged in that stroke. And do so in honor of that patient, actually in honor of the physician, it's called what? Broca's area. What's it do? It's called the speech center. It regulates patterns of breathing and vocalization, which allow you to form fluent language. Fluent speech. And in some people, damage to this will leave them literally speechless. In some cases it will lead to speech impediments. Such as stuttering or the inability to put words together in a logical sequence. Instead of saying, "I'll take that test tomorrow," they might say, "tomorrow test." So this is an area concerned with vocalization. Question?

[Inaudible]

Not to my knowledge. In fact I'm not even aware of that scenario. They speak another language that they've never been exposed to? Wow. That's mind-boggling. As far as I know, no. But Broca's area is, as displayed here, an area concerned with fluent speech. So simply put, if someone damaged this area their speech would be impaired to one degree or another. Now everything in front of this blue strip, which incidentally is most of the frontal lobe, is called the pre-frontal area, also called the pre-frontal association area. And it has a huge impact on the following issues. It's related to proper social behavior. What else? Problem solving, time management, time relationships, foresight, and judgment. Very interesting because this area. What is it? Pre-frontal association area is the last area of the cerebrum to reach maturity. To finish development. In fact it doesn't finish until age 24. So what? If you go to rent a car anywhere in this country, you have to be at least 24/25. Now why is that? You might say that's not fair. I have a driver's license. But these people who rent expensive vehicles know that your poor frontal lobes are not, what? Not developed. And you have problems with what?

[Inaudible]

And things that matter. Are you going to return that car at all or on time or intact. Yeah. My son is 31 now. When he was 18 completely incorrigible, as 18 years olds tend to be. He would not wear a seat belt. That despite the fact that he was ticketed twice and that two of his best friends were killed in motor vehicle accidents because they weren't wearing seat belts. Wouldn't wear a seat belt! Why is that? Because his poor frontal lobes were not developed. Because he had no sense of consequences. What does that mean? Sense of consequences. If I don't do this something's going to happen. Or if I do do that something will happen. So social behavior, problem solving, time relationships. There's an interesting historical footnote, medical footnote, because if you've heard of the frontal lobes at all you've heard it, I'm sure of, in the context of an antiquity procedure, which enjoyed wild popularity in the early part of the 20th century. It was called a frontal what? Lobotomy. Surgeons would go in there and just scoop out the frontal lobes and throw them away. Now why would they do that? Well because, basically, to deal with people who had these issues in terms of social misconduct. If you get a chance to watch the film – it's an old film now – but it stars Jack Nicholson. Some of you know it; it's "One Flew Over the Cuckoo's Nest." And poor Jack was just, well, antisocial. And so in the end of the movie he was given a, what, a frontal lobotomy. And you talk about zombies that's what basically you get. Now the amazing thing is that the surgeon who invented this procedure actually won the Nobel Prize for this procedure. Whoa. But to add irony to the story, that same physician was murdered later by one of his patients. So this is a rather sorry saga in medical history, because it's a completely discredit procedure, but enjoyed some popularity for the longest time. Dorothy? Yeah?

[Inaudible]

Perhaps. It's hard to really pinpoint or say conclusively. And rather than condemn young people as just being, of course, foolish in, let's say, because of this. We said that this is the last area to develop, right. It's also the first area to decline with age. So those same issues you had as a teenager revisit you later when you have troubles with time relationship, foresight, sense of consequences, and so forth. So somewhat ironic, but yet a fascinating area – the prefrontal cortex. Let's move behind the central sulcus. Everything behind the central sulcus belongs mainly to parietal lobe. And this is the area that we can show here. Where's the central sulcus? Right here between the red and the blue. The area immediately behind it, right here, is called the post-central gyrus. And this is the primary sensory area where information is terminating. Information coming from throughout your body. It has the responsibility of perception – that means interpretation – of what? Pain, touch, pressure, and temperature. So if I detect pressure on my left hand – it's the right post-central gyrus which is making that assessment. And if this is hot would I detect heat at the same time? Would I detect that it is pressure and heat? Yes. So these sensations and just these are processed in the pre-central gyrus. Therefore, a question. Patient has a stroke, damages their left post-central gyrus, what are their expected consequences? Hmm. They're going to lose their perception of pain, touch, pressure, and temperature on the opposite side. Simply that. Now you'll notice that some sensations are definitely not represented here. Do you see vision, no. Do you see smell, no. Do you see hearing, no. Those are handled elsewhere. So these sensations are the ones processed by the post-central gyrus. Everything behind that, which is most of the parietal lobe, most of this real estate in blue belongs to what. The parietal association area. This is the area that doesn't just acknowledge something, but actually – there's the word – interprets. Interprets what? Shapes, images, textures, and physical relationship of body parts. I can give an example. Let's say somebody puts a key, K-E-Y, inside your shoe and you slip it on and you start walking. Would you be aware of that? Yes. Would you, without looking, be able to tell, pretty quickly, that it's a key? Amazing. That process of recognizing shapes without using your eyes or auditory or other information is that word up there called stereognosis. It's a fascinating ability, and it's something that you've maybe practiced in the lab. In the lab we have these black bags. Some of you handled them, right. And I'll pass it around. And don't open it up, but I bet you can tell me what's in that bag, and it's not a key. It's a bone, right. So can you, just using your fingers, decipher what? Shapes, textures, physical relationships. Yeah. By the time this gets to you you'll be able to tell what bone it is. And if you're good, you'll be able to tell whether it's left or right. And you can thank what? You can thank the parietal association area. Something called stereognosis. So what would be the symptom of somebody who suffered a stroke of the parietal association area? Well obviously they wouldn't have much good stereo– –ognosis. At least that would be one of the manifestations. So not only will you be able to tell what bone that is, but you'll be able to tell me it's – blank. In other words, you'll be able to use words to express your thoughts about it. Could you reach into your pocket and determine that you have keys there, and could you fumble around and all of those keys and pullout the one that starts your vehicle. Probably. And that's, again, stereognosis. A fascinating capacity that we have. The parietal area, this area, also has some involvement in retrieving and storing long-term memories. Let's leave the parietal lobe for the green or this, I guess, lemon colored area. What's this lobe? Temporal lobe. It's described as everything below the lateral sulcus. And it consists of two areas associated with valuable sensations, namely hearing and smell. The auditory area is located laterally and superiorly, in other words right here. Right up against the longitudinal fissure. Why is it called auditory area? Concerned with what? Hearing. Now you might think you hear with your ears, but you don't. You hear in your temporal lobe. And so simply put, if you had injury to your temporal lobe what would be one of the obvious problems. You would not hear. And it's not just hearing. It's not just sound or the absence of sound. Because think about– think about that. Sound can be noise, it can be speech, it can be music. The other day I was driving in my vehicle and a radio was playing and a song came one that I actually hadn't heard for 30 years at least. And within five seconds I was singing right along with it. Something like that happen to you? And not only was I singing along with it, I can remember exactly where I was when I first heard that song. So it's just hearing, but it's interpreting and making associations with that hearing. Is this something I like, is this something that I hate, is this rap or is this The Doors or The Beatles. You know. Different for different people. But my point is this is not just hearing. It's your ability to interpret and assign a feeling about it. Maybe even a memory associated with it. And the same is true for, what's this other one? Olfactory. Olfactory refers to smell. This can't be pinpointed here. I can't point to the olfactory area, because it's not here, it's on the medial side, which is invisible in this particular image. So the olfactory area is located in the temporal lobe, but it's medially. And it's associated with smell and what? And it's interpretation. Because do different smells have different meanings to different people? Yeah. I go into an auto parts place, and I smell tires. And I love that smell. Other people go into an auto store, and they think, whoa, that's disgusting. But, again, different people, different memories, different associations. So it's not just smell; it's smell, and its interpretation. Association. What does it mean to you. What are your memories associated with that smell. Are there certain smells that bring back certain memories to you. All of these are housed in the olfactory area of the temporal lobe. The occipital lobe, everything here in green. Huge area. And it's almost, well, it's entirely devoted to one thing. It's entirely devoted to vision. Once again, people think they see with their eyes. They don't see with their eyes. Really? No. You see with your occipital lobe. And if you damage the occipital lobe you could have perfectly fine eyeballs, but you'd be as blind as can be. Because you don't see with your eyes, you see with your occipital lobe. And so, what do we mean? The information from your eyes goes to your occipital lobe, and your occipital lobe creates all of this wonderful impression that we have. Colors. Light, shades of light. So it's responsible for interpreting all the visual input that comes from the retina of your eyes. Colors, shapes, images, and even something subtle like reading text. You look up there at that chart, the periodic table of the elements. What are you going to thank for that? You say your eyes. No, you thank your what? Your– Occipital lobe. Nevermind that. What's this right up here? Some of you think that looks like graffiti or something. But actually if you're fluent Mandarin Chinese you know that that's– that's cat. C-A-T. Really? Yeah. But you have to have the proper training, right. Does everybody look at that and say periodic table of the elements and have any idea what that even means or even pronounce it. No. So, again, it's not just seeing something. Not just black and white, not just red and green, but your ability to makes sense of it. The occipital lobe also controls eye movement, because it, of course, will allow you to change your gaze. That is turn your attention to something– If I say look at that, you turn. If I say look at that, you turn. To me the most fascinating thing about the occipital lobe is not just that we see with it, but that we're able to recognize things all most immediately. And the most incredible of those abilities facial recognition. Facial recognition. There's 8 billion people on this planet, but can you recognize your sister, your brother, your mom in an instant. Yup. Thank what? Your occipital lobe. I'm going to give you a test here. I'm going to put up an image. I'm going to leave it there for exactly one second and take it away. If you blink you'll miss it. But this is just going to impress you, I think, about how amazing this is. Ready?

[Laughter]

That was up there for how long? One second. Recognize that person?

>> Yeah.

>> And I didn't go for the easy one there. I didn't go for the current president. I went for him when he was a little bit younger. But, yet, as different as he was then you were able to process what you know now and backtrack and figure out that was Donald Trump, right. That's amazing. So let's go on. The occipital lobe devoted almost entirely then to vision. Early we said that the brain is, essentially, divisible. The hemispheres are identical. Connected, in fact, remember, by the corpus– – callosum. And for the longest time it was just assumed that the left side was identical to the right side, because it at least to the naked eye there is no difference. They are mirror images. But today we're starting to see that the left hemisphere is concerned with slightly different things than the right side. And if you've had courses in psychology this is often reduced to the simple expression of right brain versus left brain. The right hemisphere, the right cerebrum, tends to be more skillful in artistic and spatial relationships. Sometimes this is called the representational brain. The left side is a number cruncher. A computer. Tends to be important or talented in what numerical and language skills. So you've heard that in conversations. Someone says, oh, he's pretty left-brained. What does that mean? Left-brained? It's actually a compliment. Left-brained. There's somebody who's really good at math, language skills. Right-brained, little different. You know. Sort of artistic, sort of out there, kind of loosey-goosey. I know– I always refer to the original

Star Trek series, but none of you know that anymore, so I have to– It's in reruns. The original Star Trek featured a Vulcan, who is that Vulcan. Spock. And he obviously was entirely what – left-brained. And then there was Captain Kirk. He was the romantic, always doing dumb things. He was more or less the right side. So this is simply an analogy or an association. It's not hard and fast. Let's finish with this. Deep within the cerebrum, here seen in blue. Do you see those blue areas? They're not really blue; they're grey. And if they're grey they're made up of what? Grey matter. Nerve cell bodies. These areas which are equally sized, equally present are called the basal nuclei. And this reminds us the word– the word nucleus is not that organelle in a cell. A nucleus is a congregation of nerve cell bodies. So why are these called basal? Because they're deep within the brain. Basal nuclei. They have individual names. We're not going to trouble you with those. But we will say this and finish with this. The basal nuclei are concerned not with initiating movement. They don't start movement, but they what? Well, yes, they adjust and subdue spontaneous motor activity. What's spontaneous motor activity? Moving something that you didn't want to move. So with all that said, what would be your expectation for someone who had a stroke or injury to their basal nuclei? They wouldn't be able to adjust or subdue spontaneous motor activity. What does that seem to bring to mind? P word. Parkinson's disease. We all know Parkinson's disease? Tremors. And so, again, how did we figure this out? At autopsy. And so injury to the basal nuclei associated with movement disorders. And that goes beyond Parkinson's. There's another condition called Tourette syndrome. Tourette syndrome, Google it. We'll leave you with that. We'll come back to this on Monday.