

Shannon:

I'd like to welcome our listeners back to the second portion of our talk with Dr. Robert Sylwester. As we've been talking about movement as a primary central organizing principal for humans, the question that comes up for me is how do we learn how to move? What is that process about? Maybe you could speak a little bit on that.

Robert:

That's a question that nobody ever thought of. For a long period of time they just thought, well, you watch other people and then you somehow or another learn how to do that. But the reality is that the discovery of this process called mirror neurons is a development; the initial discovery was made about ten or twelve years ago. But most of the really spectacular advances in this study have occurred just in the past few years. This is such an important development that's it's been likened by important neuroscientists in its magnitude to the discovery of DNA. The discovery of DNA did to our understanding of genetics what the discovery of mirror neurons will do to our understanding of teaching and learning.

Mirror neurons are incredible. The remarkable thing is that I imagine that most of the people listening to this would have access to the journal Scientific American. In the November 2006 issue of The Scientific American, the cover articles, they're listed on the cover, are two very very excellent articles on mirror neurons—a description of it. The first one is by the researchers who actually discovered them; they're Italian researchers, Rizzolatti and Gallese, who discovered these about ten or twelve years ago in Parma, Italy. They wrote an article which is an update of what mirror neurons are all about. It would be in the November 2006 issue of The Scientific American.

The other article is written by V.S. Ramachandran who is a United States researcher who has discovered a fascinating link between the mirror neurons system and autism. This is a spectacular event, because for the first time then, we can begin to comprehend maybe why ... One of the big problems with autistic people has to do with movement.

With that in mind, let me tell you just a little bit about what mirror neurons are and how they discovered it. They were doing some research on monkeys and hand movements in monkeys. What they had done was, there's an area in your brain that's about a two-inch wide band that goes from ear to ear over the top of your head. And the right side of this runs the left side of your body, and the left side runs the right side of your body, and you're upside down. And so the top of what is called your motor cortex runs your legs, and then your feet, then your arms, your hands, and then your face. So you're kind of upside down and backward. They were studying the right hand movements of the monkeys, and they were getting monkeys to do things. They were getting monkeys to push a ball, or to pick up a raisin and eat it, or to build some blocks and then push them over. And they had the electrodes, then, in to the area of the monkey's brain that basically runs these movements

where the neurons there actually physically turn on the muscle systems that carry out the movement.

Now right in front of this area is another area which is called the premotor area. This is the motor cortex that actually carries out movements. Right in front of that is an area called the premotor area. What happens in the premotor area is that you have to realize that any movement that anybody makes involves a sequence of actions. If I'm going to reach over and I'm sitting at a table and there's a glass here. If I'm going to reach over and pick up that glass and drink out of it, that would involve looking at it, and sending my arm down, and opening up my fingers, and then grasping it, and then lifting it. So there's a sequence of movements that I'm doing. And that would be a very common sequence that would probably be saved in your brain. You're going to pick something up; you reach your arm forward, you open your hand, and then you close your hand, and then you elevate it. Or if you're typing "cat" on a typewriter, while you're typing the letter "c" you have to be getting ready to do "a," and you have to be getting ready to do "t." Otherwise you wouldn't do these as a single fluid movement. Or if I'm saying "cat," and if I didn't have some way of tying these all together into a single movement, then I would say "k", and then I would say "aah" and then I would say "t". you know, as separate. But I don't do that. I say "cat" in a single movement. So this premotor area then is what primes the motor area for actually carrying out the movements.

When they were studying these monkeys, what they would see then is that whenever they were going to make a movement, just before, milliseconds before they would actually make the movement they would see that these neurons in the premotor area would fire, and then those would fire the motor neurons, and then the motor neurons would fire the muscle groups. So they would see the sequence of activities going on. So that's kind of a long get-around to the punch line of the story.

What they had to do in order to get the monkey to carry out some kind of an activity like picking up a grape and eating it, putting your hand forward, opening your digits, closing them, picking it up and moving it to your face, is they had to show the monkey what to do. The experimenters then would carry out the action, and the monkey would watch the action, and then the monkey would do it. At one point they were showing the monkey how to do something and somebody was looking at the computer screen where all of these events in the monkey's brain were being processed. They noticed that the premotor area fires just before you carry out a movement. And it also fires when you watch somebody else carry it out.

Shannon: [08:18]

Whether you do movement or not.

Robert: [08:23]

Yeah. It fires when you do the movement, just before you do the movement, and it also fires when you observe somebody else do the movement.

Shannon:

Wow.

Robert:

And they said, man, boy, this is huge, because it explains a whole bunch of stuff. For example, you can take an infant who's only two or three hours old, just right after birth, and if you stick your tongue out at the infant, what will she do?

Shannon:

Stick her tongue out back.

Robert:

Now the question is, does she even know that she has a tongue?

Shannon:

Right. Exactly.

Robert: [08:54]

And does she know how to stick her tongue out? Though normally we don't stick our tongue out, do we? normally we keep it inside of our mouth. Now it's possible to stick your tongue out, project it out, but it's not something you normally do. So the question is, how does a child learn how to stick out her tongue the first time she ever observes somebody else doing it?

Let me ask you. What happened in her brain when she saw ... Same thing. If you smile, the child would smile. Okay. Now, you give me the explanation of what you think is happening.

Shannon:

From what you said is that the child is watching a model outside of them. Their premotor area is taking in that information, and the premotor area of the brain is firing, and so those mirror neurons are activated, and she's mimicking; she's modeling what you did. So that's making the motor area go, which fires into the muscle groups.

Robert: [09:52]

And why did she stick her tongue out? She did because if you're two hours old and you have a million moves to learn ...

Now let me try this. We're not in the same room. But if we were and I were to yawn, what would you ... you'd have a tendency to yawn.

Shannon:

Yes. That's contagious. That's what we say.

Robert:

But you probably wouldn't yawn, would you?

Shannon:

May or may not. It depends.

Robert: [10:16]

Because what could you do? You could inhibit it. When you observe somebody else doing something, you have a tendency to want to do that. But the reality is that you don't necessarily mimic every movement you observe.

But what your brain is able to do,--and this premotor area would be called a mirror neuron,--what they're able to do then is that when you observe the movements of other people, there is a sort of a template of their movements that is firing in your brain to give you some indication of what other people are thinking so that you can infer the movements of others through this mirror neuron system. Now if you're walking down the street and somebody is coming toward you, you both either have to go to the left or go to the right, or you're going to walk into each other. And we do this seamlessly. So how do you know which way the other person's going to turn?

Shannon:

Well, you must be reading something in their body.

Robert:

You're reading their minds, aren't you? So to be able to read somebody else's mind and to figure out what somebody else is doing.

Now, let's go back to sports we were talking about before. When you're playing basketball,--we're in to basketball season, aren't we?—and what is the really big thing on a basketball play is to fake out the other player. Let me try this. You explain faking out. When one player fakes out the other person, what is actually happening?

Shannon:

Well, they're darting in one direction, making the other player think they're gonna go that way.

Robert:

And then what happens to the mirror neuron of their opponent?

Shannon:

It follows the impetus.

Robert:

And then you go the other direction.

Shannon:

Right. Right.

Robert:

Before they can readjust, right. Is this starting to make sense?

Shannon:

Well, so then that's really a natural response, and we learn to modulate or inhibit that, like you said with the yawning, because as I have more experience as a basketball player, I would maybe not respond to that as often, but I could also be thrown off because it's part of my physiology that triggers me to do that. It's my natural human response to do that.

Robert: [12:39]

Yeah. And that's what human beings have to be able to do. They have to be able to try to figure this out.

Now here's another interesting thing. That is, why do people like to, let's just stay with sports or something, why do people like to watch, like let's say forty-five-year-old guys, why do forty-five-year-old guys who used to play football when they were adolescents, why do they like to watch football on TV? Let me just take this one step farther. Why do the people who play the piano go to piano recitals? Let's see if you can explain it with the mirror neurons.

Shannon:

Well, my guess is that first of all, all of us would have some mirror neuron activation by just watching something, whether we had a lived experience or not. But if we've actually physically experienced that and emotionally experienced the particular activity, then by watching it, it activates, maybe it activates our mirror neurons even more so because we already have some pathway or emotional body-based experience connection with it.

Robert: [13:49]

Let me toss in another word. What you're observing is you're watching virtuoso movements, aren't you? So that when you're watching, when they watch football on television, or when they go to hear a concert pianist, here you are; the movements are occurring at a level that is beyond what you could do. So the idea then that the arts, which are basically about virtuoso movements, the virtuoso aesthetic movements, we could use the word tickle this mirror neuron system and they move it up. Even though I can't play that well, I can actually physically enjoy the movements that this person's making on the piano. Or the quarterback is going back to throw the ball or shoot the basket or all of these things.

Shannon:

So on some level I have almost a shared experience with them; because of mirror neurons, I'm able to get pleasure and satisfaction out of their expert performance.

Robert: [15:00]

Yeah. And by saying that, you raise another very very important discovery about human mirror neurons. There's this other really important element in mirror neurons. That is that when you move, there's always a chance for something going wrong, and of pain. If I move, I could run in to something. Or if I don't move I don't avoid getting hit. The idea then, every time you walk, see, you could walk on ice and fall, or you could walk on a tack. The idea then is that because we can move, we have to have some kind of a pain mechanism. So there's this huge pain system in our brain that first of all tells us where the pain is,--it's in the bottom of your feet, or it's in your hand or some place,--and then the second thing is what is the nature of this thing? What is causing it? How intense is it? What they've now discovered is that in the human brain, the part of the brain is called the anterior singular which deals with all these kinds of possibilities, these ambiguous possibilities that we have to experience. That then is a class of mirror neurons up there too. What happens then is that if somebody were to stick a pin in my finger, let's say my index finger, I would feel pain. And there are very specific neurons in my brain that would respond to pain in my index finger. And there'd be another area that would respond to pain in my big toe, and another one on my arm. Your whole body is mapped in the system so that you can know where the pain is that you're feeling and the intensity of the pain. We discovered that, and what they've been able to do then with imaging technology is to discover where in the brain, if I experience pain in my finger, where would that occur in my brain.

Now, here's what they did with the study. They would have somebody observing, let's say, sticking a pin in my index finger. And what they discovered is that in this person's brain, the person who's observing, it, is the same neurons were fired. When you observe pain in somebody else, you feel it. What's the word for that?

Shannon:

Oh, I would call it vicarious trauma.

Robert:

Or empathy.

Shannon:

Uh-huh. Empathy. Okay.

Robert: [17:43]

That's what empathy is. When there's a sense of empathy, you actually can feel it. When we moved to Eugene, Oregon in 1968 and we were building a house, the week before we were supposed to move in to the house the warehouse where all

the stuff that they had stored burned down. We lost everything we owned. We moved in to this house with the clothes on our back, and that was about it. When Katrina hit down in new Orleans last year and all those people lost everything, I remember watching that and bang! It was that same feeling. It's the sickening feeling that we had when we turned on the radio in the morning and the announcement that the warehouse where everything that we had had burned during the night. So that's what empathy is.

Shannon:

Yup.

Robert: [18:41]

Now here's another real interesting element that comes out of this study. How does a child learn how to talk? Because you can say well, I'm observing all of these things. But if a child has to learn how to talk, they have to make very very sophisticated movements inside of their mouth. There are tongue movements, and there are vocal apparatus movements. But when you watch somebody talk, you can't see what's going on inside their mouth, can you?

Shannon:

No.

Robert: [19:19]

So the question then is how does a child learn to make these very sophisticated movements inside of their mouth when they can't see their mother's mouth? So the reality is, how does the mirror neuron system explain that?

The way the mirror neuron system explains it is very interesting. All you have to do is to get something in to your brain through any sensory modality that you can. Once it's in your brain it goes all over. In other words, if it comes in as a word, it can show up as a picture.

Shannon:

Yes.

Robert:

If I say the word banana right now, there's no, I assume there's no banana in front of you. But you can see a banana in your head, can't you?

Shannon:

Right.

Robert:

Because I stuck one in your ear. See?

Shannon:

That's right.

Robert:

So you don't have to actually see something to be able to comprehend it.

Shannon:

That's right.

Robert: [20:15]

So the reality then is that when a child hears their mother talk, and the way mothers talk to children and the way all adults talk to children is through an interesting phenomenon called motherese. In motherese what you do is you go up an octave so you talk at a higher level, a higher pitch, and then you slow down the speech, and you do it in melodic fashion. Oh, baby wants a diaper changed. By doing that, and notice now what we're doing is, the first language that a child hears is basically music. So song basically comes before speech, which is a really important phenomenon – for people who throw music out of the schools. The element that we're dealing with here is that by carrying out this talking in a melodic fashion, going up at a higher level, it's easier for kids to hear. What we do then is we activate when they hear the words, actually activates the mirror neurons in the little kid. When you do this sort of talking for little kids, they do the same thing that they do when they stick their tongue out at you when you stick your tongue out. They mimic your sound. But they're not very good at it initially, because language is very very difficult to master.

So we use the term babble. So when we do this motherese to little kids, they basically will babble back at us. And we keep doing it day after day after day of parents and siblings and other people will talk to kids every chance they get. And the kids babble along. And then pretty soon the easy ones come out. And when you realize that when you talk to little infants, you basically are holding them right in front of you; you're face to face with them, and you're talking to them. And the ones that have the sort of visual element, the sounds that have the visual element like ma-ma, da-da, those kinds of sounds that have an actual visual face, is that those are the ones that come online first. You're activating the mirror neuron system, and once they get ma-ma and da-da and a few other things like that and they get constantly reinforced for it and everybody cheers, pretty soon the system comes online at about the age of two and they're off to the races. Isn't that remarkable? That explains then the mirror neuron system.

Shannon:

These people are crazy.

Robert:

If you want to get any attention in this house you want to say words. And so pretty soon then you know, the system comes online at about the age of two and they're off to the races. Isn't that remarkable.

So, that explains then that mirror neurons, now let me toss in another thing. That I said that V.S. Ramachandran has been studying autistic kids. Now what would be the problems that autistic kids have.

Shannon:

Well, they have a difficult time understanding emotional, they don't read emotions. They don't tend to mimic right. And they don't present with a facial expression or voice tone. They don't mirror that back.

Robert: [23:36]

And that'd be another one. Lack of empathy. And what would you expect when they got in and studied the mirror neuron s system of autistic kids?

Shannon:

Well, it would seem that when we talked about that sequence of events, that maybe they're taking the information in, but in that premotor area there's something wrong with where it fires, I would guess. I don't know.

Robert: [23:59]

It's a non-robust system. V.S. Ramachandran discovered. Autism is a spectrum so that you can't reduce it down to only the thing that causes, like you know, attention deficits and things like that, and dyslexia. These things express themselves in multiple ways. V.S. Ramachandran has discovered is that these kids don't have a robust mirror neuron system.

Shannon:

How interesting.

Robert: [24:30]

So the article that he wrote in the November issue of Scientific American gives you a very good analysis of the research they've done.

Shannon:

Wonderful. I'm glad you kind of linked that back in. I'm looking at our time and I'd like for us to take a little break but I'd like to think about the possibility of linking a little bit of this conversation about mirror neurons to maybe explicating some of that in relationship to our role and responsibility as teachers and educators, how that impacts that. So we'll let our listeners take a break and we'll come back.

