SUPPLEMENTARY MATERIAL: TRANSCRIPTS OF INTERVIEWS WITH JOHN GODWIN AND SANTOSH MISHRA

Below are transcripts of Catalina Montiel's interviews with Drs. John Godwin and Santosh Mishra at NC State University, conducted during Fall Semester, 2016.

Interviews

At the beginning of the interview the purpose of the project was explained and the questions followed. The interviews were recorded and transcribed verbatim, although crutched words and false starts are not included in the transcript.

Dr. Santosh Mishra (Performed on October 13th, 2016.)

Background: Dr. Mishra has a Master's degree in biotechnology. He studied neural stem cells during his Ph.D, and as a postdoc studied somatosensation of pain and itch. Currently, as the PI of a neurobiology lab in the North Carolina State University College of Veterinary Medicine, he studies the neural circuits of itch and pain sensations in mice.

Catalina Montiel (CM) - interviewer: [After brief explanation on what the project is about] **I would like to know what drives neuroscientists to become neuroscientists and how their passion is driven?**

Santosh Mishra (SH): Well, I think what drives neuroscientists, I think the most driving factor…[happens]…during this age when you are in high school to undergraduate and then graduate. I think that is the right time when you start exploring various things and then you learn this is more interesting, based on various factors…it is not only one factor.

Some people are very passionate, you know, about things which are complex because they want to solve the complexity. Some people are passionate about something which is simple, because they want to go from the simple and on [and on]. So, I mean, what I found neuroscience, the passionate thing about neuroscience is the complexity. That is the fascinating thing about this. Because you know, you want to solve something which is complex. At the same time you know you have these tools to solve those questions that you are having.

I was personally involved in neuroscience when I was basically, I would say, in college. I was actually interested in something else in neuroscience… but at that time I think the problem was the neurogenesis. Because you know the brain has many functions. I call brain the most complex, because if you look at just the brain, —and I was going through your questions yesterday—. So one of the questions in your list was why are neuroscientist now having their own field, niche, as compared to the other systems. So I am not saying the other systems are not important, yes they are important, but if you look at kidney, you know the function of kidney is excretion, if you look at liver you know its function is very… lung has function of the air, that is very clear. The same way you go with any other system. But if you look at the brain you know it tells you about sensations, it tells you how you feel, it tells you how you basically think, this is the smartest thing. You know if I don't have brain, if I take my head and chop off I won't be able to do anything…it also tells you about these sensitive perceptions which is very important. I mean if you look at animal versus human what we got is all these…different sensations. We can use our brain, we can interact with our sensory system, we can interact with our motion system, like motor regulation and all… So I think that is what I feel about the brain, that this is so complex.

At the same time, if you look at all these organs, these cells and these organs, they divide. But in brain these neurons are made only once; once they mature they are only there. And if you lose those neurons, you know, in memory for example a disease like Alzheimer's disease. People lose…neurons which causes them to forget things. And if you look at just…memory; this is so important; this is how we remember people. Let's say if I don't have that memory function gone… I won't be able to do anything. I don't recognize my parents. I do not recognize my kids, I will not recognize any of the people around me. I will not be able to make these connections to go somewhere; the whole thing is paralyzed. So, that is what the neuroscience I feel is very complex and at the same time very huge. I mean, if I have to do, I can't solve all the problems but at least I can actually go with one specific thing, and I can look at that specific thing. And if I feel that I figure that out in my lifetime, that will be great!

CM: **You started being passionate about neuroscience or interested in the brain when you were in college…**

SM: Yes.

CM: [continues with question] **Was there something specific, like a class or a friend that triggered your…**

SM: [interrupts answering the question] So I think that happened actually later at the point when I was, when I finished my college graduation. I finished my graduation in Germany, where I was working on neural stem cells, because that was a fascinating field. So you know, neural stem cells, they divide and they proliferate. And as you know this happens more at the young age than in the old age. And I was really interested in how these old people have this memory loss and other functions… and I was interested in the way on how these neurons — because I think there was—, it was not that we figured that out but we knew from the literature, that there are regions in the brain that have cells dividing, even if the people are adults. So for example like, hippocampus is involved in memory and many other functions. So if you know that there is a niche around there where cells are diving and proliferating, and then they actually differentiate into mature neurons. Same thing there are other regions in the brain again there are proliferating cells that divide and differentiate. So, I was very interested in that time, again, I think the reason is because that was a very hard field at that point of time. And it is still a hard field, I mean now people are using this as a tool for many other diseases you know. So, it was I think there was no personal feeling about [the brain at that time], it was only the field again, as I said because of the complexity, and the field that was hot at that time was the neurogenesis. And I was interested in how these neurons actually so narrowed down from but because you know when the kids are young they have these neurons, the region, there are several regions, you know the memory starts forming. But then how it narrows down in adult. But then it was when I moved here to the United States there become more personal because I moved to a more sensation field which is a completely different area in the neuroscience, and I was more interested in pain and somatosensation basically. How we perceive these different sensations. And the reason for that was…

CM: [interrupts with another question] **How did you then change your…**

SM: It was because my mom. I saw my mom. She was still suffering from this pain, you know she has arthritis… she wakes up in the morning with pain, and sleeps with pain. You know she has diabetes, and in diabetes also they have this tingling sensation, this pain sensation. And diabetes also causes other sensory problems and all. So, since my training was in neuroscience I thought that it would be a good time to move, because that was the time also like you know; I had to move now, you know, to a certain area it would take a while. But that was the time when I acquired my training in neuroscience, and then I thought okay well can I actually have this specific question field. And this is what like, changed my career from the neurogenesis field to more like a sensory field. And for the last ten years, eleven years I am actually working in this field.

Luckily, I had the opportunity because as well, that is another thing that you know. You have your passion, you know that's what you want to do. And I think what I feel is if you are determined for something, you will to do it. That is my opinion of all. And of course you need resources, you need to know people, and then you basically, you tailor your interests that way so you can actually fit into that system. And I think my PhD was where I learned a lot of different techniques which I can use into the other systems, to test that.

CM: **When you came from Germany, did you create your own lab or did you first worked in somebody else's lab before…** [interrupted by interviewee]

SM: So when I came from Germany, here, I actually worked for some other lab. So after PhD, you go for a post doc. So I was a post doc; me and my wife, we both are neuroscientists. So we had different… so we started with the same question like different regions in the brain which are involved in neurogenesis. But when we wanted to move here we wanted to move together at one place so we can stay together. And we got different places but most of the places we were like, she got the offer and I didn't get the offer. So the only place we got it [both] was the NIH. And I heard what it was in India, itself. So that was like in my dream, it was like you know in my mind, that this is one of the most premium institutions in the whole world, I would say. So luckily we both got positions in the NIH, so we started our postdoc career at NIH.

Usually postdoc doesn't have any time limit so I was there for, because of the visa and another situation, the NIH deals with things in a different way, so I was there as a postdoc for five years. Then, I actually got promoted within the institute itself, and I was there for ten years as a staff scientist.

So, the question was, I was still working with someone there and I was learning these different techniques and I asking this important questions. We were doing very basic stuff, trying to understand how different sensations are perceived. For example, if I am having pain, if I touch something hot, if I touch something cold, what if somebody pokes my hand, I feel pain. But what is the circuit, I mean how do we feel that pain? Is there something very specific or is there something not very specific? So the field, ten years back, twenty years back I would say the field was poly-modal, something like… people thought that maybe all these neurons are there and these neurons have different… So you know that for any sensation you have a receptor or something like that, so the receptors is activated, this is how the neuron works.

So the people thought that it's poly-modal, that all the neurons have these different receptors and then that is how they work. But we thought that is not the case; that's why you need so many neurons? Why, so if these are the receptors, then these receptors should be present in all the neurons; it's not only in a small subset of neurons. And that made me curious, whether there is a division between these neurons. So in the peripheral system in the dorsal root ganglia, which is the main ganglia which actually process all these sensations from the periphery to the spinal cord, to the brain… We actually focused on the dorsal root ganglia during my postdoc. So we had this question, are these neurons divided into different subtypes? And if they are divided into different subtypes, maybe these subtypes of neurons…they perform various specific functions.

Not only us but other labs also actually worked on the same field. The technique we used is we actually killed these neurons. And you would be curious, why we killed these neurons. So because we wanted to know… I mean so the thing to that, so you know from these different genetic approaches and other approaches: pharmacological approaches, there is nothing wrong with those ones, but you know there is always, as you know… the brain has this power that can process, like even if one gene is not there it can use the other one, if that is really important. So if you take the knockout it won't tell you the function of… So we used the approach where we wanted to kill these neurons, so that we can do the differential screen. So let's say, we kill pain sensitive neurons, and we looked at the genes which are grown in those pain sensitive neurons, and we compared that to let's say… I used mouse as a model system because you can do all these manipulation there. So we took the control mouse, and to look at the genes which are there but not on these deleted neurons, and that is actually how we pulled out the receptors and the neurotransmitters, which are important from progressing this message from the periphery to the central, so that is how basically… So those are the works that I did at NIH and before I came here as having my own lab.

So this was again was a dream [trying to look for words] when I was… even before the school time. So I always wanted to have my own lab, despite…the fact that I never thought that I'd come and do that research in the US. I can tell you that…this is a funny thing, because I was with my grandfather, and my grandfather was a, he was very passionate about, like you know the BBC news and other news. And I was tiny, and I heard that you know… when we have morning in India, there is another place where they have evening; that was how I was. And I never thought at that time that I would end up in those countries where…

CM: [finishes argument] **where it is the other way around.**

SM: [laughing] yes, where it is completely different. And I always asked my grandfather, how come this is possible? Like how [do] you know [laughs]? I was tiny and I didn't know about all that. So then I said okay, I was thinking, this is something that was hidden in my brain, I never talked to other people about this, that is my plan, but that was in my brain, it was always going on, it was like you know, certain things you don't…

CM: [nods and adds] **talk about yeah.**

SM: …but you think about it all the time. And you talk only when it is done, when it is like you achieved that one. Because I feel that way, because if I say that, if I talk before, it won't happen [he laughs]. So, I never told anybody but this was in my dreams. And I ended up in this institution and eventually my dream was having my own lab; but that dream was when I young, okay that I would have that kind of lab at my native place. But nowadays these things are so globalized that you don't feel where you are. I mean the important thing is that you are working, what you are, the question you are asking, and you want to solve that question. That is the important thing.

CM: **How is your average day like and how has it changed throughout the years? What do you do every day?**

SM: So that is a difficult question in the sense of that an average day, I mean, as a scientist what I feel that for me the… I mean, I have a dedicated time like where I come here and like work, let's say, eight to five, eight to six, that is my working schedule. But at the same time I think that is beyond that, it is not an eight to five schedule, it's something like you know which I am passionate about, it is something you feel you want to do all the time you know. So, this working schedule is for me to talk to the people, to talk, discuss this with others from the group, but sometimes I come early in the morning, sometimes I stay late in the night, so there is no specific… but I try to spend fourteen to sixteen hours a day for science, then I have my family at home. So I usually go back like six o'clock, spend time with my kids and my family and then when they are on bed then I come back and then I try to do my work… sometimes I won't be able to do it so I come early in the morning. That is actually how I divide my time. But like you know, I think if I feel something that there is no boundary, like you know you just want to do it. You just want to come and finish those experiments. And to see that you would you, I mean.. get positive results, you get negative results but based on those you move to the next step. So I think, that time wise, I would say that I spend normal working hours but then I go beyond that. And I teach all my, I tell all my postdocs as well. So this is what, like you know, I mean, not saying that other things are not good, yes, everything is good but you know, for this, for science, I mean if you are trying to solve a puzzle or solving a question, time should not be a limitation there, you have to go beyond the time, beyond the things; we all have twenty four hours but then we have to spend time in a way so we can actually… and also ask this intelligent questions and we don't want to solve all the questions, but if you solve only one single good question, I think that is what the important thing is.

CM: **So what disciplines do you use mostly in your lab?**

SM: So I [just] started my lab here, so I am actually building up. So right now I am in a very explorative phase, where basically I am trying to set up something very basic, but what I have done before, that is what my future plan is, to use interdisciplinary approach, so not only where you can use only pharmacology or some drug, but like we use most genetics, we use pharmacology, we use optogenetics which is kind like in trend right now, because the reason is you can ask specific questions with those ones. You can use, as I mentioned you before, we figure out this different neuron populations within the sensitive neurons, so now we made this optogenetic mice where we can actually, with the light, we can say that this mice would only have pain but not itch, but then the itch mouse has only itch but not pain. So these circuits are defined. So the problem is like, so if you have for the drug…it has not very specific action, you know you can, whatever the receptor they would find it would block the function of those receptors; so that is not a clean way to deal with it, so we came up with this idea. Like we can find this neuron populations and we can shine light to say "okay now this is pain" and can use now this drugs to inhibit that pain. So that can be used as a potential tool to screen these different drugs, you know. I mean the other reason is for example like you know, in mouse specifically is very difficult to say whether they are painful or whether they are having this… because they can't speak. If somebody poked me I would say "ouch" or I would express my feeling; that it is painful or it is scratching, but in mouse you can't do that. So that is why you have to come up with this, like you know, tools where you can say now, this is very specific. And what we did so far, we can use that now to actually deal with it. And then also, might actually, my interest is still there but what I am looking more now, because we have identified these basic circuits now, so we are using those circuits in chronic forms. So for example, like you know, chronic pain, chronic itch, you know what happens when people suffer from psoriasis or atopic dermatitis, if you know these, where people have symptoms, itch as a symptom, they scratch a lot. Same thing with the chronic pain, like people like my mom, she suffers from arthritis, so what are the neurons… are peripheral targets but these targets are actually accurate to these neurons. So they are going to the peripheral system but then they are also central in the brain, so we don't know. So…my plan is to move from the periphery and then actually trace these neural circuits to the brain…because eventually the target is the brain because this is what processes. Brain is the only one [organ] that tells you whether this is itch or whether this is painful…like you know, someone is sitting there and telling you "okay now scratch", "now is painful". So if you look at the behavior of pain and scratch, it is different, [but] both of these are processed in the motor system. So for example, like you know, brain sends the signals, but then your motor, says, like, for example, pain: move away! …I think these are all the curiosities, you know, I think the fascinating things, like you know, it's complex at the same time, but I think now we have these tools, and I know there are different tools coming up and that is why I think these neuroscience field is really getting more exciting and interesting.

CM: **Why do you think Neuroscience wasn't a field before but is now growing so fast?**

SM: I think because of the tools. I think, I mean initially, like you know, I mean the reason is because people are realizing this, because this is the main thing, which is processing information. But initially, I'll give you an example…right now we have big problems, big big problems…like diseases, several different kinds of diseases. So still when I talk to the people there, pain and itch, they feel like "ohh this is symptoms". For like my mom, I mean, for her pain is like daily life, just like eating or you know doing other stuff. So the same I mean, I think the diseases are so prevalent…that people have more focus on those aspects than looking at something that which is not that problematic. And also like I think the time like the tool, I mean if you go twenty years or thirty years back, I mean we did not have all these tools. I mean these tools are in the last ten fifteen years, we have these tools coming out. People started like well you know, this are peripheral targets. If we actually look at the central thing, and if we can look at that central, which is actually controlling… So I mean, look at stress, just simple stress, stress can do a lot of different things. Not only to the brain but other organs as well. But what is processing those stress, is the brain processing the stress, you know. So let's say, you know, if the professor says something to you, gives you stress something, and the processing of your brain, you know, he may be, his intentions was not to stress you, but it's your brain how it is processing, I am just giving you an example you know. So for some things like, I mean if we are in the room and somebody says something, maybe I take a stress, and maybe you don't take a stress, so what is going on is the brain processing of those verbal cues or this… how my brain processes it. So I think this time, maybe twenty years, maybe the tools and the awareness of the people like you know the thing that we have to focus more you know they think we probably have to focus more on neuroscience. I think that is why they… and as I said if you look at just the brain itself it does so many different functions so which if you just look at any individual organ they have very specific functions. So I think that is the reason probably this is standing just as a single field than other biological field.

CM: **What has been your most important contribution to the field?**

SM: I would say I haven't reached…that point. But what I would say that what we did find so far is the circuit, the neural circuit for the itch sensation. And I think that we can use that circuit [to study] for different diseases. Like you know where itch is a major symptom so you know the itch is not only like the bug bite or some chemical irritant in use or some… many of this diseases, different diseases, where itch is the major symptom. So for example like patient with kidney diseases, patient with heart failure, like some of them neurogenic pain and neurogenic itch, is for example like you know… I know that people with multiple sclerosis; they have itch as a symptom; infections where itch is a secondary symptom. So I think, the major contribution is looking at this neural circuit, if you find this neural circuit for let's say, acute sensation and then… if you, it is something like you know, you want to know… If you go from here to your campus, if there is no GPS, nothing, it would be very hard to reach that target. So now having this basic discovery what we can say, that we can actually, move around this to figure out what is happening in this different diseases. So I think, that is what I feel, that is probably the first stage, but I think eventually, I would be very happy to find a drug which can either inhibit pain, like for people who are suffering from pain at the peripheral level, or something to make for itch. For because, again my lab, has focused in both pain and itch and the reason is because these circuits go very parallel. They are completely different, so itch is different than pain, but they actually in the spinal cord, they actually in the center, they actually merge somewhere, and then they cross top. And then at least you know from the pain perspective, because people with pain they don't itch, because there is this inhibitory circuit going on in the spinal cord. So I think if we can find something which can block this different sensations… I think that would be the real good thing.

CM: **What aspect of the brain or the nervous system amazes you the most?**

SM: I would say its complexity. I think that is the… because if you look at the brain it has different parts you know. You have this front part, then you have the way it divides cerebrum, then you have the spinal part, you know… So I think the complexity, and again, the complexity in terms of the cross talk. And I think this is again, this is what the field is growing up, where they are looking at the circuit, and if you go and read the literature you will find how complex it is, how different regions in the brain, how they actually talk to each other, and then they decide and come up with a decision, and say "okay well you know all what wins during the whole cross talk, so like you know what makes this pain to say "well okay I am the strongest" and this causes this people to suffer from pain. So I think the complexity of the way of this is what actually amazes me.

CM: **What are your dreams about neuroscience as a field and how would you like it to go forward in the next fifty years?**

SM: Well, actually that is a very good question. At the same time it is very difficult to answer. I think in another fifty years, if we can tease apart the whole brain and then you pull them back and say well you took this part, this has this function which is gone. And as I said, we were talking about the circuits, how these different parts talk to each other. Now what, for example, pain. If you just look at pain, pain has two functions: first it warns your body something is bad is happening and pain is back when some disease is there. To this again, what controls them, and something like, I would love to see the whole brain like this, you know, and then you say well the circuit is going to this and this is the responsible circuit. And if you take that out and if you say well even if I take this out or if you add that up, it causes this memory enhancement or something like people, I would really love to have these drugs made for this people who lose their memory, especially because my grandfather, he lost his memory…

CM: [adds to his comment] **mine too.**

SM: …and it was really bad to see them, like they didn't recognize their son, daughter or family, you know. So I think, that is the ultimate thing, where if we can find that out we can make these neurons happy so they can… there is nothing worse than your own parents would say "okay who are you?" You know with whom you stayed for you know your whole childhood, and… And I think probably understanding this brain as a whole and if you —I don't know whether I will be alive by that time— but if we can solve this complexity. But I have a hope…I am not sure if you've read [about] these people who work on making the brain big, this expansion… This guy [regrets forgetting his name] but he, I think one of the problem with studying brain is because of the size. And what he did is he; actually, he used this "diaper" theory. You know the diapers when you put water on them they expand. So he used the exact thing to expand the brain; to see all the molecules inside the brain. And I think that this is one of the good techniques you know. I mean I still have my own comments on that, but at least if we expand that, the whole thing, yes we can actually, probably get to know and understand the complexity of the brain in more detail. I those are other, I think good discoveries I would say. And other ones like optogenetics where you know you can with light, you can actually shine this light in very specific part of the brain, and very specific neurons, and then ask specific questions. I think eventually narrow it down to the single unit where you know that this is the real cause of any problem. And then if you know that then you can actually target that. Then comes the clinical or the discovery part of the drug you know, because then you can make those drugs. We still have these drugs, I am not saying that… but you know again or example, in our field they are these pain things, and we use this drug to actually inhibit the pain receptor but the side effect of those receptors are basically, if you inhibit those receptors what happens is your body temperature goes down. So those are the problems. That is why you want to get into the very specific question or very specific unit and then from there you can actually ask that, if you can target it or not.

CM: **It has been very interesting to hear you. I think this is all I have for now.**

Dr. John Godwin (Interview performed October 25th, 2016)

Background: Currently, as the PI of a neurobiology lab in the North Carolina State University College of Sciences, he studies animal behavior and sex determination with a genetics approach. He developed the Integrative Physiology and Neurobiology concentration in Biological Sciences at NC State University.

Catalina Montiel (CM) - interviewer: [After brief explanation on what the project is about] **First I wanted to know: was your bachelor's degree in neuroscience or how do you get to neuroscience?**

John Godwin (JG): Unexpectedly [laughs], it was in zoology. And then I headed off to grad school because I wanted to do community ecology of coral reef fishes and I would not have predicted that I would end up doing neuroscience. And I started doing some work in physiology, and then I joined a lab as a postdoc and moved more into the neuroscience. And there I've been [laughs].

CM: **What specifically triggered your passion for neuroscience, what do you like about it?**

JG: I always liked behavior, but I am interested in an integrative approach to behavior. So trying to understand, I mean ideally, hopefully aspirational, I'd like to, I'm intrigued by the idea of connecting variation of gene expression and gene polymorphisms to differences in behavior and try to understand where behavioral variation comes from.

CM: **Interesting… So who influenced you the most throughout your career; was it a peer, a teacher, a mentor?**

JG: Probably, a couple of different mentors.

CM: **Was it more because of research?**

JG: Yes, I mean you know I think just the approach to science and it looked like a good job to have.

CM: **Yeah if you are interested in animals… so because of your interest in zoology that is why you do research on animals instead of humans or… is there another [interrupted by answer]?**

JG: Humans are not a great experimental animal for most things. They are good for some things like psychology where you ask, animals what their product preferences are… you can do it with a rat if you are clever. But I think, yeah, I am more interested in why animals do what they do in their habitat as they evolve.

CM: **Can you describe a little bit what you are studying right now?**

JG: Sure, any particular part? We are looking at sex change in fishes and a big question there is how does an animal turn social signals into a change in physiology. And try to understand specially, reproductive physiology. So the work we work on, female changes sex and becomes a male in the course of about a week, and this is from being social dominant. And so how that translates into changes in the reproductive axis. We are curious about this; it is sort of an interesting thing, but it is also a general phenomenon. Almost all animals we know, they react to social cues that changes their physiology, we just don't understand how. So that it is one thing.

CM: **So that is the advantage, I guess, over rats or rodents?**

JG: Yeah, but they show, these fish they show a couple of big advantages. One is they show really dramatic phenotype change. So going from being female this week to male next week [laughs] is pretty dramatic. We also, we can watch them do it in the field. And then one thing is nice about sex-changing fish: is rat have also this important sex determination but then also differentiation processes, often times when they are already out of the womb, so they are, you have probably seen them, they are this little pink things when they are fine, but they are not an animal really interacting with their environment in important ways. Whereas when the fish change sex, they determine their sex, and they are fully grown adult animals. You know they are out there interacting with their social system so, it's unusual in that way. Something you can't study in a mammal. Plus, we can look at them in nature, which is hard to do with rats. It's doable but it's hard.

CM: **Do you actually study them in a vivarium here [in the university]?**

JG: No, no. We… it'll be nice in some ways if it worked but we do most of that work in the field in Florida, or other places in the Caribbean.

CM: **If you weren't studying behavior would it be easier to study them in a vivarium or would it still be better [interrupted by answer]?**

JG: It really depends on the question you are interested in. Sometimes you can study a lot of things in vivaria but sometimes what you end up knowing is what happens in a vivarium, when you might want to know what is happening in nature. And so it can be harder to go out there, but I think sometimes the answers you get are more relevant. Again it depends on the question. For something like what Dr. Meitzen studies, basic striatal differentiation in the brain it's great, you know, nice control conditions and you can focus on things you are interested in. For the sorts of questions we mostly do, it's less great.

CM: **What is your average day like and how has it changed throughout your career in research?**

JG: Way too long [laughs], sixteen to eighteen hours a day this month. One thing is hard to get away from is… I am here mostly [in his office], right now writing a grant, trying to support the work the students and postdocs do. And so my job moves from me working in the lab and gathering data, to looking at data and thinking about it; sort of managing the overall enterprising, finding money, to keep on going, and for stipend for students so they can eat [laughs again].

CM: **Do you still do bench work?**

JG: I do some. I was in a lab for almost three hours last Friday [being a Tuesday the day of the interview]. So, I do some, I do a lot of stuff in the field; I am the best in the lab on catching fish. We can't do anything until we catch the fish. So I am still important for something [jokes about it].

CM: **Do you actually go there [referring to going into the field] depending on the season or is it many times a year?**

JG: Hardly, I mean, we go in the summer time because students can participate, so they are able to do it. And I teach in other semesters. So that is part of the reasons. Partly, because the waters are calmer and in winter time it gets a little rough.

CM: **Which disciplines do you use more often in your work? Is it genetics mostly?**

JG: It might depend on how you define genetics; it's a broad view, for some people some have a more narrow view. We do a mixture of genetics, behavior, and neuroscience; some endocrinology thrown in.

CM: **Is there one that contributes more to what you are trying to answer?**

JG: I don't think so. I mean, we need all for what we are interested in. So which is sort of connecting the genome to the behavior of the animal or in some other cases to their sex determination. So not everything we do is behavior.

CM: **Why do you consider that neuroscience wasn't set to be a field before the 1920s; that it wasn't that studied as it is now? And how has it developed so increasingly throughout the last decades?**

JG: Right, I think probably big part of it was that we had no idea. Even about the basics of functions. So it is a difficult type of field when you don't have some sort of foundational principles. And even just the fact that they were separate cells in the nervous system, you know it took Ramon y Cajal to come up for a good way to stain and start to ask you how the characteristics work. So, I would think that would be a great part of it. And then technically speaking, where there is still a real challenge. So I mean, compared to a liver, not to disparage liver or gonads, it is complex for a heterogeneous organ [referring to the brain]. And I think it is just technically more challenging in some ways, at least for a lot of kinds of questions. I mean that is the biggest difficulty about the brain right? Because you might have a hundred kinds of neurons in a small area, that is why optogenetics has been a such a revolutionary thing, because you can start to tease that apart in complex tissues. So, I think behavior itself has, I don't know if it's always been regarded as a science, it tests clear hypothesis and things.

CM: **You mean it is more related to psychology…**

JG: Yeah, though you know there's a lot of things that are...like I was a science fair judge and I liked one poster this kid made, because you know he put up a sign, it was a human psychology experiment, and it was please clean up after your dog, or have a nice day, and he took careful notes on how people whether people cleaned up after their dogs or not. And I said [he said to himself] it's not really science, why do you mean it's not. He had a clear testable hypothesis, he had good data, he rejected his null hypothesis, I mean that is science you know. So people's idea of what is science and what isn't, and they can need a fancy machine to do science which is not true.

CM: **How would you rank the importance of neuroscience in learning about the human body? Do you consider it to be like more important than any other discipline?**

JG: I don't know if more important, but certainly critical. I would say what makes us human is certainly our brain, what makes us exceptional I suppose…among the animals that is the part that makes us more human in terms of uniqueness and being different. The other parts I mean they are kind of… and poorly armed, we can't handle climatic variations very well, it is really our brain that is the reason they are so many of us around. So, I could justify it on those grounds.

CM: **What do you consider has been your most important contribution to the field?**

JG: They are so many [laughs]

CM: **you can list the ones that you most like, the most interesting for you.**

JG: I mean yeah, I think in terms of [stops and thinks for a while]. I'd say it's not there yet, we'll see, ask me in a few years if I get this proposal I submitted in August, if I get that one funded. That's it, it is being evaluated by the National Science Foundation right now.

CM: **Nice, good luck with that.**

JG: Thank you. I think that we've shown direct social influences on how the brain functions. They are independent of any input from the gonads. But we also know they are some influences of gonadal steroid hormones as well, that we can quantify. So, going forward, I would see, I have an idea that could tie estrogen effects on aggression across, I think maybe and ends vertebrate animal types, from rats to wrasses, to birds. [laughs] And so that is what could be one of the big ones in neuroscience if we could do it.

CM: **I guess that will answer your question about what are your dreams for the field?**

JG: Yeah, certainly for neuroscience, I think the dream would be actually understanding how social cues are processed to affect neural function, health and disease. And just basic aspects; and I think it's going back to the humans. I mean we are social animals right? I just like to joke at, that is the reason the guy who made Facebook is a billionaire [laughs] you know if we weren't social animals he would just probably be a guy on the bus, so maybe he would have found something else to make money, probably, he's a really sharp guy … But I don't… we don't really have a good handle on that, and if you think about that, we know that people recover better in hospitals when they have social support; it's kind of sad to think about a social pill; but if we understood the mechanisms… [laughing] "you don't have any family but take this pill".

CM: **What aspect of the brain or the nervous system amazes you the most?**

JG: [thinks for a while] I don't know… The process of learning is pretty remarkable, I would say. Having modified circuits and reason through problems, it is sort of an outstanding thing that we don't begin to understand, we understand some basics, you know, obviously, but…

CM: **[aggregates] we have a long road to travel.**

JG: We do so… Was that helpful?

CM: **it was, thank you!**

Interview Transcription Ends