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Terrence Sejnowski receives Swartz Prize for Theoretical and Computational Neuroscience

The Society for Neuroscience (SfN), an organization of nearly 40,000 scientists and clinicians, will award the Swartz Prize for Theoretical and Computational Neuroscience to Terrence Sejnowski, Salk professor and head of the Computational Neurobiology Laboratory.

The $25,000 prize, supported by The Swartz Foundation, recognizes an individual who has produced a significant cumulative contribution to theoretical models or computational methods in neuroscience. The award will be presented during Neuroscience 2015, SfN's annual meeting and the world's largest source of emerging news about brain science and health.

"Dr. Sejnowski is deserving of this prize for his role in founding and growing the field of computational neuroscience, his commitment to training and mentoring young scientists, and his many major research discoveries," says SfN President Steven Hyman. "It is an honor to recognize his tireless efforts to understand the computational resources of the brain and to computationally model how brain activity becomes behavior."

Terrence Sejnowski, the director of INC and head of Salk's Computational Neurobiology Laboratory.

Sejnowski has demonstrated significant breadth in his research career. He has developed artificial neural network models as well as learning models for birdsong and neuroeconomics. He helped develop the algorithm for independent component analysis, a method now widely used in many fields.

Most recently, he demonstrated how the loss of a critical receptor in a special class of inhibitory neurons in the brain may be responsible for

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neurodevelopmental disorders including autism and schizophrenia. He also showed how little known supportive cells in the brain called astrocytes may be responsible for controlling patterns of brain waves (gamma oscillations).

"This is a great honor to have SfN bestow a prize named for Jerome Swartz, who did so much for the field of computational neuroscience by supporting centers at Salk and other major research universities," says Sejnowski.

In addition to his efforts to bring attention and funding to the field of computational neuroscience through organizing conferences and consulting for numerous agencies and panels, Sejnowski always found time to run experiments in his lab. These ranged from investigating the pacemaker neurons of electric fish, to modeling the changes that occur in the hippocampus during learning, to understanding how sensory information is represented in the cerebral cortex.

Sejnowski earned his PhD at Princeton University and taught at Johns Hopkins University before joining the faculty at the University of California, San Diego, and the Salk Institute. He was named a Howard Hughes Medical Institute investigator and now holds the Francis Crick Chair at the Salk Institute.

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The above story is reprinted from materials provided by The Salk Institute for Biological Studies.

What Makes You So Smart, Computational Neuroscientist?

Terrence Sejnowski talks to Pacific Standard about searching for Sputnik, receiving pleasure reading material from a Nobel Prize winner, and being a science nerd.

Terrence Sejnowski always knew he was the "science nerd," but it was a stint with his high school's radio club that sent him on a path that would lead him to becoming a pioneer in computational neuroscience. The Francis Crick professor at the Salk Institute and the director of the Crick-Jacobs Center for Theoretical and Computational Biology talked to Pacific Standard about searching for Sputnik, the problem with schooling, and receiving pleasure reading material from a Nobel Prize winner.

Schooling when you were growing up?

I grew up in Cleveland, Ohio. I went to a Catholic elementary school. I think it was already clear in fifth grade that I was the science nerd. In high school, I joined the radio club. That had more influence on me than any course that I took, primarily because of the person who ran the club, Mike Stimac. He was an extraordinary individual. He had a master's degree in physics and, more than the other teachers, he was a hands-on type of guy who liked to have big projects. We had one called Moonbounce to put a big radio antennae on top of the high school and bounce signals off the moon. This was during the Sputnik era. The radio club was one of the first to track Sputnik when it went up. He was also head of the aviation club so I learned how to fly.

It wasn't until I got to college at Case Western Reserve where I learned much about physics. That was a very formative period of my life too.

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You knew that you were a "science nerd," but did you think of yourself as very smart? How did you view yourself along the intelligence spectrum of your classmates?

I did very well in terms of exams and contests, but what I really learned in high school was that that wasn't really the goal. Being a good student and being smart isn't necessarily what's important to be successful. It was really at the radio club where I learned how to build things, to have goals, how to plan long-term projects. As the president of the club, I learned how to manage people and work with them toward a goal. It was not formal academics that formed my future career. It was really how to take the knowledge that you've learned and turn it into a new direction.

Were you conscious that that's what you were learning back then?

It was absolutely conscious. In the radio club, we would ask ourselves, "What is your mission?" When you're in high school and you ask that, it makes you think twice about how to achieve it. It was something that helped prepare us for the future. My guess is that other people find similar inspiration from sports, band, or any other extracurricular activity.

I think that the way we have organized our schooling is unfortunate. We've separated the life lessons from the classroom lessons. It used to be the case that there was one classroom with many different ages and they could all learn from each other. What other institution do you know where you're segregated by your year of birth? It's really weird if you think about it. It's done for practical reasons. They've turned school into assembly lines. Just as you have a car that goes down an assembly line, a student goes down, the teacher rivets knowledge into their head, and then it's on to the next teacher. The reality is that when you're in the workplace, you're dealing with people of all different backgrounds, talents, motivations, and ages. That's the world that students need to get exposed to. Fortunately I was. I attribute it to Mike

Stimac, the mentor who really had a big impact on my life.

Did you consciously continue that type of eduction in your post-doc years?

That wasn't conscious in my mind, but when you have life-changing experiences, they are with you all the time. They are always in the background, even if you're not fully aware of the influence that it has. I have been particularly fortunate with my mentors, starting in high school but also when I was doing my graduate work. At Princeton, I had the good fortune to work with John Wheeler, who is an extraordinarily influential and creative physicist who taught me all sorts of lessons not just about physics but about how you think about problems and what's important. He coined the word "blackhole." He taught me how to coin words. [Laughs] And John Hopfield. I did my Ph.D. with him. He was making a transition from physics to neuroscience at the same time I was. Having someone of his stature who was making that leap made it possible for me at a time when that wasn't normally done.

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Why did you choose neuroscience?

I was working on general relativity, and the area that I was interested in was gravitational waves. Joe Weber, who had claimed to have measured them with an aluminum cylinder, unfortunately had a bug in his computer program. It was clear to me that [making] an advance in physics would require something on a cosmological scale, either a satellite or a huge array of gravity wave detectors. We still haven't discovered gravity waves.

When you're young and you want to make an advance and there's no prospect of data, it's discouraging. I had reached the point in physics where I knew what was important from John Wheeler and what was difficult to advance without data. I was looking around and fortunately I had friends who were in biology. At that point in the 1970s, biology hadn't quite made a transition to molecular genetics, but it looked like there was going to be a tremendous amount of data, not just from genetics but also recordings from neurons. It was appealing because the mysteries of the brain were as important and exciting as the mysteries of the universe. So why not? You could do the experiments with your own hands; you didn't need to have a super-conducting super-collider, which was canceled as it turned out. A lot of my friends who went into particle physics had to look for other jobs. I think I made the right decision early on that biology would have a better future, at least over my creative lifetime. I haven't looked back.

Do you read for pleasure?

I do. I like to read biographies. I just finished Turing's Cathedral by George Dyson. I'm reading an autobiography written by a friend of mine, Mike Gazzaniga. His most recent book, Tales From Both Sides of the Brain: A Life in Neuroscience, is all about how his work led to a whole new insight into how consciousness is distributed broadly between the two hemispheres.

How do you find new books to read?

Often it's from reading book reviews: the New York Times, the Economist. Turing's Cathedral was a gift from Roger Guillemin here at the Salk Institute. He's a Nobel Prize winner and very, very generous.

What are you working on now?

Right now we're in the middle of a series of papers that a former student of mine, Ben Huh, and I have been working on for several years. They've reached a point where they are almost ready to submit. They focus on the motor system and how we make movements, arm movements for example. Using a framework called Optimal Control Theory, which comes from engineering, but also analyzing it using methods from physics. One of the themes of my career is to try to look at classic problems that exist in neuroscience and psychology and see through the lens of physics and math what the structures would look like. I try to get some insights to make predictions and do some experiments. I think this series of papers is going to have a big impact on the field of motor systems and optimal control.

There's also the BRAIN Initiative, the 10-year national grand challenge that was launched in 2013. I helped shape the project by serving on the advisory committee to the National Institutes of Health to set the priorities, and continue to help guide it. The goal is to accelerate brain research by a factor of 10 and create a neurotechnology sector of the economy as vibrant as the biotech sector. The impact could be as important as the man on the moon for space and microelectronics and the Human Genome Project for precision medicine.

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The above story is reprinted from materials provided by the Pacific Standard.

The original article was written by Noah Davis.

Faculty Spotlight - Dr. John Iversen

Auditory Perception: Music, Rhythm and Movement

We sat down with Dr. John Iversen, who has been working on disentangling the role of music and rhythm in coordinating perception and motor actions.

Could you tell us a bit about your background?

I'm a cognitive scientist, and I've been studying auditory perception for quite a while. I was previously at the neuroscience institute, and while I was there, I focused on the study of rhythm and how people perceive complex sequences of sound. I came to INC because I was very familiar with the work of Scott Makeig, and I wanted to use some of some of the same methods - EEG and ICA – that they used. In addition, I received a grant from a San Diego foundation to start a study with Terry Jernigan at the Center for Human Development. Those collaborations were some of the reasons why I came to INC.

What are some of the projects you're working on right now?

Let me take a step back. One of the reasons why rhythm is so interesting is that it's a very tractable system for understanding sensorimotor interactions. Rhythm and timing is one step above typical phenomena we study in perception, such as color, shape or pitch, and they're tightly related to the movement. My current focus is to test what is called the "action simulation for auditory prediction" (ASAP) hypothesis, which posits that our perception of rhythm doesn't just depend the sound that we hear. Instead, it predicts that the motor system is necessarily and causally involved in shaping our perception of the rhythm. Some of my work under a NSF grant probe this hypothesis. We're asking whether and how the motor system modifies auditory perception, and what the connection and circuits are that enable the modifications.

"The motor system plays an important role in shaping the perception of rhythm."

The second project I'm involved in is the SIMPHONY project with Terry Jernigan. This project studies the impact of music training on the brains of children, and that's something I have been able to piggyback on another data collection study called Pediatric Imaging, Neurocognition and Genetics (PING). It's been a great opportunity for me to do a kind of study that I wouldn't normally be able to do on my own, because it involves hundreds of kids and big data analysis for brain imaging and behavioral testing. The project is in its fourth year now, but the actual data collection has been staggered in that not everyone started on the first year. For example, this year, we have about a hundred participants that have two data points, year one and year two.

Some of the preliminary findings from these subjects suggest links between the rhythm production and other higher auditory capabilities, such as the linguistic abilities. We also found that structural differences in the motor system predict auditory perception. Kids with larger motor and premotor cortex areas did better on experiments where you have to perceive musical beat, which is consistent with the idea that the motor system plays an important role in shaping the perception of rhythm.

There's a lot of other work that suggested the close-knit relationship between the motor and perceptual system, but my goal is to understand the dynamics of the circuit. It's one thing to say that the motor system and the auditory systems are working together, but we really need to know what the interconnections between those systems and what kind of information is present at each stage in the pathway. To that end, we mostly focused on studying the dorsal auditory stream, including the auditory cortex, parietal cortex and the premotor cortex.

What is the relationship between your project and the Gamelan project?

Although our project is separate from the Gamelan project, we have a lot of common interests. Alex Khalil (who heads the Gamelan project) and I worked together on a grant, and we just received a three-year grant from NSF to set-up a collaborative network of researchers to

The "Studying the Influence Music Practice Has On Neurodevelopment in Youth" (SIMPHONY) project aims to study the impact of music training on the brains of children.

Dr. Iversen describes the effect of music on the brain at the TEDxSanDiego event (https://youtu.be/M2sqXbwlaWw).

follow-up on what the science of learning center has been doing. For this grant, we chose to look at the group brain dynamics in classroom situations. We will be using low-cost, lightweight EEG headset from Cognionics, so that we can buy 25 of them and put one on each child in a classroom. This will be really exciting to us, because we will learn how the children are learning simultaneously, and not just one person at a time in front of a computer. This project is called the group brain dynamics and learning, which we fondly abbreviate as GOBLIN.

We have two ideas about how to use the data collected this way. The first idea is very simple: perform the standard, traditional EEG experiments, but using data from 25 people. That is very exciting, because the yield in data is immense compared to bringing each child separately into the lab and studying them. We can literally do a study in a week, if we wanted to. That is hugely exciting to us. The experiments we proposed include looking at brain responses to sound and connecting them to language abilities or comprehension in the classroom. This will allow us to develop auditory processing profiles of the children, using what's known as the complex auditory brain-stem response (CABR), which has been shown to be enhanced in musicians and correlate with reading and language abilities. It's interesting to be able to characterize a whole classroom at once this way.

The more speculative idea is to look at the group brain dynamics. There are a growing number of studies to see at what points of a movie or a lecture all the brains tuned in, so you can make a map of the attention state of the class. This map can then be correlated with how the audience comprehends what they're hearing, for example. Since there is immediate feedback, the technology may one day allow the teacher to adjust her lecture based on the brain activities of the kids in the classroom. That is going to be a lot of fun.

There is a lot of collaboration for this project: Alex and Tzzy-Ping Jung are involved in a major way, and we also have someone from Stanford and from George Washington University collaboration as part of the network. This is a collaboration inspired by what TDLC is doing, and it's fantastic that we're encouraged do that at INC.

Do you have other projects you're working on currently?

We also have a new grant from UC MERCI, which is a university of California-wide collaborative. It's a planning grant, and its goal is to create a collaborative network by researchers studying music cognition and music. We explore how music impacts the lives of Californians, how music can be used to heal the sick and what a technology of music can learn from the neuroscience of music. We've been doing a series of symposia for this collaborative, rotating around different UC campuses and webcast to others. The symposium we held here had discussions related to how much affects education and health. We took advantages of some of the experts being in town for the subsequent Mainly Mozart event.

The week after that, we also had our first UC MERCI workshop at UCLA. This brought about a hundred researchers and graduate students together from very different disciplines: music, pedagogy, ethnomusicology, history, computer science and neuroscience. We got together for three days and gave short talks to introduce our fields to each other. For example, there was a lot of interest in using music for rehabilitating from geriatric syndromes, such as Parkinson's disease. The idea was to foster the growth of collaborative network, and many came of this workshop.

There are two other grants that I'm involved in a major way and lead by Scott Makeig. One of them is about data-mining EEG data from ADHD kids in a large study done at UCLA. The idea is to take the analysis of EEG beyond just looking for a biomarker of ADHD; we are developing a landscape of symptoms and brain responses, so we can start clustering sub-symptoms and connectomes of different brain dynamics. It's an exercise in developing and improving our tools to analyze very large datasets, which has been an interest in this lab for quite some time.

The other project that just started this month is a study of human navigation at the MoBI lab. The goal of the project to understand is the kind of transformations that take place in the brain as someone's exploring and learning about the space, and we have people navigating around the room wearing wireless EEG. The clever trick in this experiment is to create mazes, but using the auditory input instead of visual input; so we call it an "audio maze." The idea is to have virtual walls around the room, and using the motion-capture equipment on the body, produce sound when the hand gets close to the virtual wall. The combination of touch and sound creates a very convincing sense that there's really a wall there, almost like from a new sense modality. The benefit of this experimental setup is that we can reconfigure the maze instantly, so that we can change something about the maze while it is still being learned and measure how they react, for example. Another is that this setup discretizes the information from the environment: instead of getting information in a continuous flow as we normally navigate, the subjects collect discrete samples. That gives us a more comfortable handle on analyzing the data, as we can look at the brain responses to each of the touch events. It's interesting to see how much information is needed to learn the maze.

One thing that's common with all of my projects is to probe the active process of perception: our entire perceptions combine with the ongoing processes in the brain to shape what that perception is. For example, when you listen to music and you hear a beat, you're listening the music through that lens. Beat is the scaffold and the structure for music. You hear sounds in relation to your internal sense of beat, and that's a very different way of hearing. It's not just what the sound is, it's how the sound relates in time to your internal sense of beat. I'm a drummer, so that's very exciting. There's no question that an upbeat and a downbeat - they're completely different, even if it's exactly the same physical note. The feeling is different, and the musical meaning is different. So how does the brain do that? That's the one goal in all of this.

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INCEVENTS

INC CHALK TALKS

10/15/15	**Arnaud Delorme**	EEGLAB - Recent Developments and Future Directions
10/29/15	**Marcela Mendoza**	Bayesian Inference in Distributed Architecture for Mobile Applications
11/03/15	**Ryad Benosman**	A Framework for General-Purpose Computation Using Neurons, Precise Timing, Delays and Synchrony
11/05/15	**Lewis Chuang**	Beyond Steering in Human-Centered Closed-Loop Control
11/19/15	**Joe Snider**	Prospective Optimization with Limited Resources

Special Events

9/25/15 - 9/27/15

2015 Mozart & The Mind

Mozart, prodigy among prodigies Three days packed with cutting-edge scientific exploration, music and fun! Stimulating daytime talks, concerts, and interactive installations on the UC San Diego campus and evening "Keynote Performances" at the nearby Auditorium at The Scripps Research Institute (TSRI).

Academics and students can claim a 50% discount on any ticket by calling Mainly Mozart Box Office at (619) 239-0100 x 2.

Full agenda and more details can also be found here.

12/03/15 **2015 MURI Winter Workshop on Memory Consolidation**

2015 MURI Winter Workshop takes place at the Roth Auditorium, Sanford Consortium for Regenerative Medicine.

Full agenda and more details can also be found here.

More information: *http://inc.uscd.edu/events.html*

inc at a glance

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Carol Hudson, Management Service Officer

Swartz Center for Computational Neuroscience at INC
http://www.sccn.ucsd.edu
Scott Makeig and Tzyy-Ping Jung, Co-Directors

Machine Perception Laboratory at INC
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