Tanya Domi: Hi, this is Tanya Domi. Welcome to The Thought Project recorded at the Graduate Center of the City University of New York, fostering groundbreaking research and scholarship in the arts, social sciences, and sciences. In this space we talk with faculty and doctoral students about the big thinking and big ideas generating cutting edge research informing New Yorkers and the world.

Tanya Domi: This week's guest Tony Ro is a presidential professor of psychology and biology and director of the Ro Lab at the Graduate Center. Ro and his colleagues are investigating the brain's deeply complex cognitive and neuronal architecture and its role in determining our attention, perceptions, and action. Ro joined the Graduate Center in 2015 after seven years at the Colin Powell School for Civic and Global Leadership at CUNY City College. Ro will direct a new master's program in cognitive neuroscience in fall 2018. Welcome to the show Tony.

Tony Ro: Thank you for having me.

Tanya Domi: Can you begin by explaining to our audience in lay person's language the focus of your lab's work?

Tony Ro: Sure. My research tries to understand how the human brain processes sensory information to the point at which we become aware of our surroundings. So my lab focuses on essentially the perceptual processes in our brain that allow us to have representations of things like color or faces, small objects that appear in our world, and how the brain actually processes that information to the point at which we become aware of that information.

Tony Ro: My lab mostly focuses on visual perception. It's been estimated that more than half of the brain is involved with processing visual information. We are visual creatures after all. But we also focus a bit on touch perception and auditory perception or hearing perception as well and how these different sensory modalities interact with one another and also how sometimes in the cases of a condition that's referred to as synesthesia, as these different sensory modalities might actually evoke responses in other sensory modalities.

Tanya Domi: How much do we really know about this process and how does it compare to the knowledge of other cognitive functions?

Tony Ro: We're actually at a very early stage in our understanding of how the brain functions generally speaking, but when it comes down to cognitive functions as well we really have barely scratched the surface. We don't really understand much of what goes on. We've kind of narrowed down some ideas as to what parts of the brain may be involved with some of these processes, but even there it's becoming much more complex where there are a lot of interaction between brain areas and ways in which different brain areas communicate with one another to allow us to have these types of experiences and perceptions.

Tony Ro: Yes, so it's a very early on stage of this discipline, it's pretty much a vast territory of unknowns, it's like the last frontier in science as some refer to it as where we really don't know what's going on and the complexities of the brain are so large that, yeah, it's going to take many decades if not centuries to even gain some further understanding of what's happening there.

Tanya Domi: Yeah, and the new frontiers, the phrase that comes to my mind is as a nonscientist one of the phrases used to describe this information of gathering and sorting process is the "cognitive in neuro architecture." But is there a single architecture or does the way in which our brains process makes sense of this information? Does it vary?

Tony Ro: I think it does vary. It varies depending on the function that's under question. It also varies depending upon which brain areas are contributing to that function. Some of the same brain areas contribute to multiple functions, so, yeah, there's a lot of different ways in which these different functions can come about. In fact, the same brain area even doing the same function can signal information in different ways at different frequencies or strengths of signaling to other brain areas that may convey certain types of information under some circumstances and other types of information in others.

Tanya Domi: That's interesting because we might experience certain stimuli like the waves that are typically interpreted as color or sound or even how we might even experience emotions. Can you talk about that?

Tony Ro: Yeah, there are a lot of individual differences in the way in which people interpret information. So with the same object that's reflecting the same wavelengths of light that should be perceived as the same color amongst individuals may be viewed or seen as being very different in addition to some individuals for example being colorblind, different individuals have different sensitivities to different types of colors and their general experience of those colors may vary greatly amongst each other.

Tony Ro: So even though the physical object is the same, the way we see and interpret those objects may vary from individual to individual, and it can actually be quite dramatic in many cases where some people may have different distribution of photo receptors in their eyes that process the information differently or different sensitivities for hearing. We know that as people age for example the higher frequencies of sounds aren't as clearly audible as people who are younger, and so there are a lot of different ways in which that same information can be perceived very differently or in fact missed altogether by some people.

Tanya Domi: So what are the potential medical implications of your work? I've read for example that researchers are developing ways to send visual stimuli to the brain through other senses like the tongue or the ears like you were just mentioning so that maybe blind individuals would ostensibly be able to see, actually see. Can you tell us more about this kind of research?

Tony Ro: Yeah. So my lab has been actively involved in some of this type of research and I collaborate with a lot of others who do this type of work. One of the active

collaborations I have here at the City University of New York at City College is a computer scientist, Zhigang Zhu, who we've been working together on trying to develop assistive technologies for people who have for example visual impairments. The idea behind a lot of this work is we can use say a camera to detect images that then a computer algorithm and some hard working convert into different types of signals that can be delivered to a person through touch or in another collaboration I'm working on through stimulation of the brain directly through just little electrodes that you can introduce current into the brain with.

Tony Ro: A lot of these different tools that we're trying to develop, these sensory substitution devices or prosthetic devices may in fact eventually be able to help individuals who have impairments such as visual or auditory. So yeah, we're working a lot on these types of questions as well.

Tanya Domi: It's fascinating especially accessing the sensory nerves of the tongue to be able to hear it's my understanding, it's possible?

Tony Ro: Yeah. We've tried it with vision. We've tried to convert visual images into patterns of stimulation that can be delivered onto the tongue using a device that was developed in Wisconsin. But it turns out actually that the tongue doesn't have very good ability to discriminate different types of shapes or patterns of stimulation that we put onto it, and so that approach hasn't worked as well as we were first very excited about and hopeful for. But some of the other approaches that have been attempted are ones in which the brain itself is stimulated by connecting these grids of electrodes for example to a camera that can convert the image and stimulate the brain directly or through some devices that a company in San Diego has been making where they can insert a grid of electrodes into the eye and convert camera signals into patterned stimulation on the eye.

Tony Ro: In all of these cases it turns out that our ability to see is much more detailed and fine grained and sophisticated in any of these devices that we're coming up with are capable of doing. I guess what it really comes down to is that we've had billions of years of evolution essentially to form our eyes and our senses in the way that we have them now and are able to do and are very crude ways of trying to artificially make them aren't really cutting it anywhere near it the ability of a normal eye would be able to do. It's been a very large challenge but it's also been very insightful too in terms of just understanding how the brain works, how our sensory receptors work, and how these different types of functions come about in general.

Tanya Domi: Some of the most interesting work you've done is it not in the area of synesthesia and multiple sensory perception?

Tony Ro: Right.

Tanya Domi: Can you talk about that?

Tony Ro: Sure. Yeah, that's been a very active area of my laboratory research these days. We initially started out sort of coming across as finding, doing a lot of, we're just looking at multi-sensory interactions, how touch for example might be affected by a visual input. But it turned out that we started testing an individual who had brain damage and as a result of the stroke she had that produced a small area in her brain that was damaged from the stroke.

Tony Ro: She developed synesthesia where she started feeling on the left half of her body different types of sounds that she would hear. Synesthesia is the mixing of the senses where one sound can evoke ... Or sorry, one sensory input can evoke sensations in another, so a sound can invoke touch or a touch can evoke a visual stimulus, a sound might produce a colored flash of light. So it's all these different ways in which these modalities can get mixed up.

Tony Ro: There are many different types of synesthesia. The first one that we studied in the lab was from brain damage, was an acquired synesthesia and she ended up having this auditory tactile synesthesia where she would feel sounds on her body, on the affected portion of her body that that brain area was normally processing information from.

Tony Ro: More recently we've been very actively involved in testing individuals who just have developmental synesthesia or congenital synesthesia. They are just born with it. There's no brain damage there. These individuals it's very systematic in terms of how they experience their synesthesia, what they may for example with the letter A, always see a color orange with it, and different letters produce different colors. They may also for certain sounds see very specific colors. They may with certain touches or sensations on their body may see certain types of visual effects that go along with it.

Tony Ro: There are lots of different ways in which it comes about. What we've been doing recently is we've been trying to understand how the brain produces these types of perceptions in individuals. What we found in the patient was that there seems to be a lot of cross wiring between brain areas that process these different types of sensory information that kind of evoke responses in the other. We're currently doing a lot of studies now where we're trying to assess precisely how the wiring and responses in very particular brain areas are driven by information from other sensory modalities.

Tanya Domi: That's pretty amazing, and given the research that you've been doing in your lab and the research larger on the mind and brain now the Graduate Center is going to offer a master's program next fall that you're leading in the cognitive neuroscience area of research. This is going to be available to master students. Can you talk about that and what people that enroll in this program, what can they gain, obviously great research and insight, but what can someone do with a master's in cognitive neuroscience? I like to hear more about your thoughts about this new master's program. It's very exciting.

Tony Ro: Right. We are very excited about this new program. It was approved on November 22nd 2017 by the State of New York and we are now accepting applications for students to enroll for the fall 2018 semester. It's a very exciting program where students will be able to gain experience doing research in cognitive neuroscience as well as take fundamental

coursework in the cognitive and neuroscience domain, including courses in statistics, core courses in neuroscience, and more specialized courses in cognitive neuroscience as well.

Tony Ro: It's a very exciting time to be at CUNY in the cognitive neurosciences. We just in June of 2017 got our research dedicated state-of-the-art magnetic resonance imaging or MRI scanner at the Advanced Science Research Center, so we can take individuals and put them into this MRI scanner and measure their brain functions as they're doing all sorts of different types of cognitive tasks. Students in this master's program will be able to participate and actually gain experience with this.

Tony Ro: We also have a lot of other tools and methodologies available at CUNY for these students to gain experience, and we have a lot of EEG systems to measure the electrical activity of the brain during different types of cognitive processing, and this is a tool that neurologists and epileptologists typically use to measure locations of seizures in people who have abnormal electrical activity. But we can also measure normal brain function with it as well.

Tony Ro: We have lots of different ways in which we can modulate brain function and disrupt it noninvasively using these different types of tools. So we have the full gamut of resources available to do cognitive neuroscience research at CUNY and it's very exciting.

Tony Ro: In addition to gaining experience in these tools and methodologies, these students when they graduate will be very well positioned to enter into a doctoral program in a specialized area related to cognitive neuroscience, but also get jobs very likely straight out from the program. We teach and do a lot of statistics as part of the research in cognitive neuroscience. We're always analyzing data that we're acquiring and so these students will gain a lot of experience in that and so they could get jobs as a data analyst at various different types of companies.

Tony Ro: They could also if they learn how to run the MRI scanner go off and get a little more training to become an MRI tech where they can acquire scans at hospitals. They can be also research assistants in other labs. There are a lot of different opportunities for these students to actually get employment outside of the cognitive neuroscience area in general.

Tanya Domi: I want to thank you for being our guest today.

Tony Ro: Thank you for having me.

Tanya Domi: Thanks for tuning into the Thought Project, and thanks to today's guest, presidential professor Tony Ro.

Tanya Domi: The Thought Project was produced in partnership with CUNY TV, located at the Graduate Center in the heart of New York City, with production, engineering, and technical assistance by [Sara Fishman 00:18:39] and Jack Horowitz. I'm Tanya Domi. Tune in next week.