Vishaak Gangasandra Interviews Yale Neuroscience Professor Dr. Sanganahalli

**SUMMARY KEYWORDS**

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**SPEAKERS**

Basavaraju Sanganahalli, Vishaak Gangasandra

**Vishaak Gangasandra**

Welcome again to the Livers Academy global leadership podcast. My name is Vishaak Gangasandra, a scholar of the academy currently studying a double degree of medicine and biotechnology. Over the past year, we've become accustomed to the terms uncertainty, volatility and change, which have all become synonymous with the global challenges the world is facing. Due to this, however, our attention has been shifted away from the rapid changes in the research and development sector. Over the millennia, society has progressed from the stone age, to the industrial age, to the space and digital ages. The advent of the next chapter in humanity is soon approaching, coined as the biological age, where we expect the augmentation of health and wellbeing with advanced technological innovation. The industry displaying the greatest potential to catalyze this societal shift is that of neuroscience. Today, I'm honored to host leading neuroscience professor from the Yale School of Medicine. Dr. Basavaraju Sanganahalli. Dr. Sanganahalli completed his PhD in neuroscience, and has since gone on to publishing over three dozen internationally known papers, primarily focusing on fMRI technology and the roots of Alzheimer's disease. Thank you for joining us today.

**Basavaraju Sanganahalli**

Thank you for having me today.

**Vishaak Gangasandra**

Your journey is an inspiration to younger aspiring students. Could you talk us through your university and career experiences that led you to where you are today?

**Basavaraju Sanganahalli**

Sure, yeah. I'm Basavaraju Sanganahalli currently working as a neuroscientist and also research faculty in the department of Radiology and Biomedical Imaging at Yale University School of Medicine. First of all, being a postgraduate in physics, I had never dreamt that I'll be doing a neuroscience research someday. It was totally an accident I moved from [a] solicited physics career through neuroscience research. I had a bachelor's degree in electronics and then postgraduate in physics, and during my postgraduate in physics, I was specialized in X-ray crystallography. We're using this tool to understand the structure of single crystals. And also we were introduced to study some small macromolecules and protein structures there I got interested in multimodal physical tools to study biology at molecular level. So later, I did my PhD at National Institute of mental health and neurosciences Bengaluru, one of the premier neuroscience research institution in the world. Here I got a solid foundation in fundamental neuroscience. After finishing PhD, I was really looking forward to learning some of the non-invasive multimodal neuroimaging tools to study brain function. So I was fortunate to get into Yale University School of Medicine, to do my postdoctoral fellowship and preclinical imaging. After finishing the postdoc, I became research faculty, and I've been there since ever.

**Vishaak Gangasandra**

Wow, it sounds like you've done it all. What stands out clearly is your passion for the field. What inspired you to go into neuroscience? And what do you feel makes It's such an intellectually stimulating discipline?

**Basavaraju Sanganahalli**

We all know that brain is one of the fascinating and incredibly complex organ. I always wondered since childhood, how does brain resistance and information, how we perceive the external world through all of our senses, like brain continuously receives all of the information from all five important senses like touch, vision, hearing, smell and taste. It processed information, stores information and recall information time to time. All of these processing happens in extremely super speed. You know, the brain is always active. Whether waking sleeping, dreaming, it's a restless brain. Although it weighs only 2% of the body weight, it nearly consumes 20% of the total action required. Why does brain require so much of energy? To give an example if you just take a one millimeter cortical tissue of human brain it requires around 1017 ATP per second. For the whole cortical gray area it requires around 1020 ATP per second. For 24 hours the working brain requires like 1025 ATP per second, such an incredible energy demanding organ. The ultimate goal of neuroscience is to understand biology of mind, how the complex interaction of genes, proteins, neurons and circuits can lead to individuality of consciousness and behavior. So recent advances cell deepened our understanding of how brain functions and today neuroscientists from wide varieties of discipline. I can give examples from biology, psychology, genetics, chemistry, computer programming, physics, engineering, linguistics, medicine, ethics, law, and also philosophy all employ a powerful arsenal of these techniques to address the biology of mind and to provide insight for treating more than 100 known associated psychiatric and neurological disorders in the brain. I feel this is so exciting to work and learn about how brain processes and information using all these multimodal neuroimaging tools currently available.

**Vishaak Gangasandra**

It's very fascinating, isn't it? So, Dr. Sanganahalli, in your time at Yale, you're focused on translating theoretical principles to clinical applications around the topic of aging. Could you briefly describe your experience and some of the projects yourself and Yale are planning in the future?

**Basavaraju Sanganahalli**

Yeah, sure. Here at Yale we have a magnetic resonance research center, where we house a very high field MRI preclinical and clinical scanners for various neuro-imaging applications. I'm currently using very high field, for example, 9.4 Tesla and 11.7 Tesla, preclinical scanner for translational neuro-imaging applications. My current research is mainly focused on understanding of biophysics of brain functioning, facilitating the translation of basic science research to various clinical applications. I am currently collaborating with various clinical scientists both at Yale and also outside Yale in the preclinical animal models of healthy aging, Alzheimer disease, epilepsy, early life stress, schizophrenia, stroke, mild TBI and spinal cord injury. So as we age we lose our sensory and cognitive abilities. We know that there is aging there is a brain structure loss and the gray matter and white matter, we can actually assess by using multimodal magnetic resonance imaging, we can assess the brain volume changes in gray matter and also white matter changes. Also, we can use the functional conductivity measurement by using resting state fMRI, traditional functional magnetic resonance imaging maps the brain activity indirectly, but this resting state fMRI without giving any stimulus we acquire series of images for 5 to 10 minutes, then we take a voxel at the somatosensory or the motor region, take the series time series of signal and start coordinating across the different regions of the brain. It shows the functional connectivity, for example, there are certain regions in the brain like prefrontal cortex and posterior cingulate they are always connected, meaning that they have a default mode networks. So these networks keep changing as we age, and it is more pronounced in some of the neurological disorders like Alzheimer's disease. So that can be actually a biomarker. So right now I'm focusing mainly on like studying olfactory dysfunction in aging, we actually lose sense of smell as we age, but it is more pronounced in Alzheimer and Parkinson diseases. 80 to 95% of the patient lose sense of smell. I'm actually trying to develop a technique to measure the olfactory responses from shouting from olfactory bulbs to the higher olfactory cortexes, and also trying to find out the relationship between the age and sensory loss in both aging as well as in Alzheimer disease models.

**Vishaak Gangasandra**

Wow, it sounds like there's so much to be excited for, especially for younger students going into the field and especially for yourself. Now, some believe that society's next greatest leap is in biological innovation. What role does neuroscience and neuro-economics in particular play and how important will it be in commercial innovation?

**Basavaraju Sanganahalli**

This is mainly of neuro marketing. Currently, there are many companies, for example, you take food and beverage industries or a selling company like Amazon, Facebook, Google, already, they're using this neuro marketing approach. It's a very complicated business skill, like the field of neuro marketing, sometimes known as consumer neuroscience, which studies the brain to predict and potentially even manipulate consumer behavior and decision making. So over past few years, several groundbreaking studies have demonstrated its potential to create value for marketers. Just give an example the beverage companies like Pepsi and [Coca] Cola always competed with their advertisement, how they can actually deal with the consumer decision making. So even like selling company, Amazon, for example, to select coffee machine, they actually advertise is one of the best coffee selling machine and that they actually rated five star like people always the consumer goes with the rating, that survey is biased. This kind of decision making is influenced by the ad company say though all of these companies are using this neuro marketing with artificial intelligence and then trying to sell their product in a better way. Similarly, Google when you're browsing something on Google, and you're associated with Facebook. Facebook started leaving the cookies to know, they already know what you are searching for. Facebook started advertising those products. So these companies are making you know, they're investing billions of dollars in neuro marketing. Also, there are some technological advances which reshape business in nearly every industry. Many companies are still like basing important decisions on questionnaires like focus groups, like credit card swiping, and also doing some GPS tracking. And also, I remember there are recent breakthroughs in neuroscience are helping us to understand more about what holds a person's attention and what motivates them. The potential business applications really outstanding. So I read somewhere recently that some of the business school, there's a famous Business School in US like Wharton Business School, that actually introduced work on neuroscience initiative, which is based on Wharton’s introduction to brain science for business course. This program actually presents a unique opportunity to learn directly from the scientists who are making new discoveries.

**Vishaak Gangasandra**

Currently, there is much speculation regarding our present capabilities. How much do we currently know in neuroscience and what could be achieved within our lifetimes in the near future?

**Basavaraju Sanganahalli**

Wow! This is a Good question. So currently we are using many multimodal neuroimaging tools some vary from invasive to non-invasive and also the range from different spatial and temporal resolution to map brain activity from simple synapse to system level. So throughout brain, the flow and processing of information is mediated by an anatomical connection that unifies cells into circuits and circuits into systems. So, these connections include both local connections from time within specific brain region and long range connections spanning multiple areas and distances. I can say like future development for next generation of like recording neuro technologies will increasingly require this participation of scientists, not only from neuroscience from physics, chemistry, molecular biology, electrical and neuro engineering, material science people and also computer science people. So development of new generation of large scale recording tools will permit more incisive investigation of numerous problems in neuroscience that have been approached in only limited ways today. For example, how is sensory information transformed into higher order perception? That's a big question. How is short term working memory encoded? What are the circuit mechanisms underlying the decision making? I just spoke about neuro marketing This is concerned to neuro economics, what fundamental logical neural mechanisms mediate motor control. Already technologies are coming home for example, earlier stroke or Parkinson's patient cannot even move their hand right now they can use their remote control to turn on a TV or turn on a light switch. Also, how do multiple brain areas communicate and work together as behavior and tasks demand change? So how do neuromodulatory signals re-model circuit dynamics and brain states, how are internal cognitive models of word encoded, updated and accessed to make predictions and guide future actions. I feel we still have a long ways to go on developing these sophisticated neuro technologies for improving cognition and behavior.

**Vishaak Gangasandra**

Leading on from this is a question that I'm sure listeners would be adamant to hear the answer to. Recently, there's been much hype around Elon Musk's neural link brain chip, which is being developed to read and transduce brain activity. What are your thoughts on the expansion of such technologies? And where do other emerging industries such as big data and AI fit within the field of neuroscience?

**Basavaraju Sanganahalli**

This is a great question. Yeah, actually, first of all, I in my lifetime, I didn't think that it will happen so fast, but it is emerging. First of all, this is a great invention and very cool technology. I don't know the listeners might know that neural link basically works by recording and decoding electrical signals from the brain. Using like more than 1000 electrodes implanted in different regions of the brain, for example, we can implant these kind of electrodes into your motor cortex that can coordinate hand and arm movements. Using these data, we can calibrate and decoder by mathematically modeling the relationship between the patterns of neural activity and different you know, movements they produce. This actually helps, for example, neural prosthetics. So currently, there is a project I can go in detail about, it's called the Big Brain Project. I think it's in Canada. Just to give some brief background neural imaging methods mainly, you know, rely on accurate brain models has grown to develop reliable approaches for probing the brain. Researchers in brain simulation and artificial intelligence have a growing need for detailed description of internal organization of brain regions in terms of local morphology, like cell densities or connectivity. Currently established computer based 3D neuroimaging tools cannot reproduce freshly cut brains, particularly for very convoluted like cortical regions and in subcortical areas. With the advent of this Big Brain, a human postpartum brand that has been sectioned, stained for cell bodies scanned at very high resolution, and then they digitally reconstruct in 3D. They believe that there will be an improvement in precision and quality of neuroimaging support for qualitative and quantitative investigation of the brain. This is very fascinating because they aim to extend their model by further increasing resolution and integrating multimodal data, working closely with the neuroimaging community, brain modeling and artificial intelligence communities to unleash the potential of research. Currently, there is also a Human Connectome Project, you know, and the Big Brain Project, they're all working synchronously with all this machine learning and the AI approach.

**Vishaak Gangasandra**

With neuroscience playing an integral aspect to our future, leadership in the industry is crucial. How can innovation in neuroscience be dealt by effective and decisive leadership to ensure regulation to maintain privacy, autonomy, etc?

**Basavaraju Sanganahalli**

This is a question regarding the neuroscience of business. It is going from public to political for example, last year's election how this played a big role in even the political election too. So innovations in leadership and strategic decisions will show how the brain works and how to apply neuroscience principle in any organization to shape an improve management, for example, team building and innovation; and learn how neuroscience can enhance talent identification like improved team selection, monitor training, enhance and broadening and cultural fit, and enrich marketing and communication strategies and improved client relationship, again, to improve leadership capabilities by understanding the science of decision making, including how neural constraint can lead to poor decisions and how to overcome them. So they're actually trying many approaches, apply brain training and cognitive enhancement with any organization to improve productivity, cultural fit, and job satisfaction, etc. This is just what I learned through the literature. But many companies are already recruiting psychologists to assess their personal stress and cognitive behavior. They're trying to improve or enhance their productivity by using a lot of approaches to get a, you know, business output.

**Vishaak Gangasandra**

So given this, what can we as members of the public and potential scientific researchers be doing right now to lead and encourage investment into biotechnological improvement?

**Basavaraju Sanganahalli**

Of course, it needs huge public support in many ways investing like taxpayers money on research, increasing federal funding to conduct research, always there is a huge demand for federal funding to conduct research. The substantial investment needed for target discovery and validation are spread across public. Since I live here I know like National Institute of Health and the National Science Foundation are the major federal funding agencies, and also partnering with industry and private funders lowering the risk to any one entity. Several countries have recognized the urgent need to invest in brain research as a priority for economic development and improve health of their citizens. Over the past several years, many countries and I think recently, European Union launched large scale projects nearing billion dollar investment. So what we call this IBI international Brain Initiative has been established to coordinate these kind of efforts across existing and emerging national and regional brain initiatives. Actually, US also did, I think, during the Obama administration, they bought this program called brain initiative to develop new technologies and funding to improve technologies, for early biomarker detection. So this neuro new describes how to be involved on new opportunities for global collaboration that are emerging between scientists, scientific societies, for example, funding agencies and industry, government and the society.

**Vishaak Gangasandra**

And if members of the public right now wanted to invest in these biotechnological companies, would there be a substantial return on their investment? And would you personally recommend that they

do so to benefit not only themselves, but the wider community?

**Basavaraju Sanganahalli**

A lot of people are trying that already, you know, the government is giving like small scale industries, a lot of support to do that. They are actually collaborating with a lot of academic, people taking a molecule from bench to bedside, for example, treatment therapies. So it's a big thing like going from phase one to phase two to phase three, it is not a jump, it's actually a coordinated information, you know, from the small scale industries and academic universities, and the support from the government.

**Vishaak Gangasandra**

By the sounds of it, creativity will become everything in the future, especially for scientists. So how can aspiring scientists harness creativity to succeed in medical research? And what can they do to become transformational leaders?

**Basavaraju Sanganahalli**

Yeah, this is the most important thing. So I insist on the convergence approach to just explain what is this convergence, the integration of Life Sciences like physical sciences, mathematics, engineering and information technology, often referred to as the convergence has emerged in very recent years as a powerful approach to research with the potential to lead medical and technological breakthroughs. So investing in convergence from early research through clinical applications will transform health and provide healthcare cost savings. The example number one like convergence can enhance early diagnosis. Catching problems at the outset can save costly later stage or last minute treatment. And also, you know, with this neuro technologies like wearable, smart devices that monitor health and wellness will alert patients and doctors to inspect the health issues. Paired with the advances in health information technologies that integrate molecular and genomic data. Wearable monitors can also help to prevent disease progression. Meanwhile, there are some algorithms to enable data driven medical decision, can help doctors to use the best available evidence quickly. Convergence can also increase the effectiveness of treatments, new immunotherapies and vaccines will enable our own bodies to better fight the disease. Minimally invasive medical devices including those deploy recent development in nanotechnologies, they actually reduce the instrumentation size, will provide steady, regulated drug release along with powerful tools for investigating you know sub-cellular process. I can also talk about nano robots what we call for drug delivery. So there are some new regenerative and cell engineering strategies for tissue and organ repair will reduce the need for organ transplant and heal wounds faster. A new smart prosthetics like robotic arms and will connect to the central nervous system, so where wearers can sense the world and control their movements. These are some of the examples.

**Vishaak Gangasandra**

There are claims that many psychological studies provide inconclusive or incorrect results resulting from the high pressures of journals to output publications. As the saying goes publish or perish. Do you feel it is important for future scientists to be aware of this? And would you suggest that there be a greater push to nurture ethical conscientious scientists?

**Basavaraju Sanganahalli**

Haha. Yeah, as a scientist, we all need to publish our data to document our findings. We all get benefits, you know, from the published work or the published documents. Sometimes there is a pure pressure to publish in high impact journals for example, publishing in very high index journal like Science, Nature, Cells takes much, much longer time, because it has to undergo like rigorous review and it is time consuming, sometimes it takes like one and a half to two years, I personally faced this thing. Secondly, some of the biological experiments require more sample sizes and also there is a concern for statistics nowadays. For example, like physics experiments, we measure acceleration due to gravity, G is equal to 9.8 meters per second squared. Limited trials are enough to get you know reproducibility but biological experiment reproducibility, repeatability and sample sizes is a big concern. So now actually we are moving like now big journals are saying that the statistics p less than 0.05 is no more valid, we need to go very higher. That means you need your more sample sizes. So, there is an enormous amount of stress involved too in your organization or the funding agencies. They always demand to publish in high quality journals. And I myself as being a scientist get biased. When I am reading a new article, I always go and look at a review article which is published in high impact journals. Even though we know that you know, it's this is the system that we are all, you know, scientists, we have to do our best.

**Vishaak Gangasandra**

That's very true what you're saying. Now, to finish off, I'd like to ask, what should young people passionate about medical innovation be doing now to help change the world in the future?

**Basavaraju Sanganahalli**

First of all, you have to develop a passion. Deciding what you want to be or what you want to do is the first step making any success in any field right? You have to have patience, develop a grit, no procrastination, understand that. And we all do mistakes, mistakes or failures are vital part of discovery. And as a young investigator, first of all, you have to find an advisor who will listen to you and your ideas and thoughts. No matter how far or short along your career path you are. I have found this myself crucial to building scientific confidence early on starting in my undergrad. Strike a network, and attend conferences, even if you feel like you don't have to contribute anything. There are many established people, for example, I go to society of neuroscience, there are 40,000 people accumulated in one place. And they go from the neurosciences emerged from basic neuroscience to developmental to computational neuroscience, there is a vast area an different experts from all over the world are coming and discussing their, you know, discoveries. So this established people in the field will see it is a privilege to interact with you don't become specialists too early. That's my experience. It's great if you can amass a multitude of experience as it will always not only be fuel your growth, but also enrich your skill set and approaches, and might give you a very valuable perspective that differ from this niche expert. That's all I can say with my experience.

**Vishaak Gangasandra**

Well, thank you very much for that message. I'm sure that our discussion today would have helped in inspiring the next generation of neuroscience leaders. It has been a pleasure to have you here today. Dr. Sanganahalli.

**Basavaraju Sanganahalli**

Thank you. I really enjoyed the conversation.

**Vishaak Gangasandra**

I'm Vishaak Gangasandra and that brings us to the end of this episode of The Livers Academy Global Leadership Podcast. With today's discussion, we've learned how our future will be marked by the infusion of disciplines to augment our wellbeing and we are in desperate need of critical problem solvers like all of you listeners. So whether you're studying medicine, biotechnology, engineering, business, art, or any other field of your choice, stay passionate, because you get to decide what the world is tomorrow. This podcast was recorded by Vishaak Gangasandra with production and editing by Daniel Seed and supported by the University of Queensland.